NATURAL GARDENING HANDBOOK

- Mulching & Composting
- How to Use Organic Fertilizers
- Pest Control Without Synthetics
- Soil Testing Laboratories

BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS
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BROOKLYN BOTANIC GARDEN RECORD
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NATURAL GARDENING HANDBOOK

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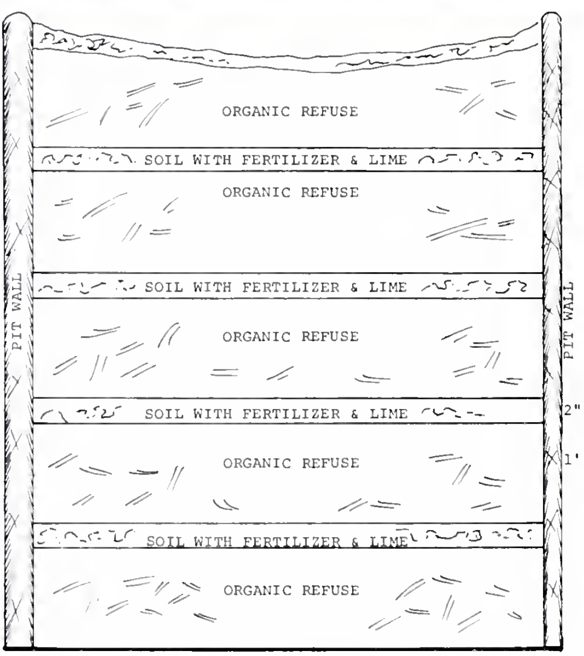


TYPICAL COMPOST PILE SHOWING ALTERNATING LAYERS OF ORGANIC REFUSE AND INOCULATING SOIL.

Two aspects of natural gardening—the praying mantis, left, and the compost pile, lower left, shown in diagrammatic form. The praying mantis is a beneficial insect whose presence in the garden is always welcome. Among the pests that a praying mantis can destroy are aphids, spider mites and scale insects. The praying mantis at left is laying eggs in her usual egg-laying position—upside-down. The compost diagram shows alternating layers of organic refuse and inoculating soil in an arrangement suggested by D. O. Ezell and E. V. Jones. The compost is enclosed in a chicken-wire frame supported by four posts. The height of the pile can vary, as can the amount of organic refuse in individual layers. This compost pile can be described as a "club sandwich," in which soil, fertilizer and lime form the "bread" and the organic materials, the "fillings." For other methods, see pages 70 and 71.

LETTER FROM THE

BROOKLYN BOTANIC GARDEN

There is a groundswell of interest these days in a new kind of horticulture—natural gardening. Many people refer to it as "organic" gardening, and each year a growing number of books devoted to its philosophy (or religion, if you will) are appearing on the shelf. A number of them contain much useful information, others let the tenets run a bit ahead of the facts. For readers who have requested a nitty-gritty look at this kind of gardening, the Brooklyn Botanic Garden has turned to Robert A. Wearne, Horticulturist for the Extension Service of the United States Department of Agriculture in Washington.

Our Handbook is the result of the efforts of Dr. Wearne and twenty outstanding Contributors. Most of the people who have made this special-feature issue possible are extension service agents around the country who have had many years of practical, down-to-earth experience in growing plants for their best performance. This experience can be a guide for you in exploring this phase of gardening.

Let us try to clarify one point. The Botanic Garden's role is to provide readers with no-nonsense information on various aspects of gardening, not to promote one way of growing plants over another. If you prefer to hoe your row by a particular method and have had good luck, stick with it! The main point to an increasing number of Americans with leisure moments is the pleasure itself of gardening. Henry M. Cathey, President of the American Horticultural Society (and a leading plant scientist in his own right) has referred to this as "quality time"—time to think, review and relax. However, there's little pleasure in raising a young squash plant, then walking out into the garden and seeing it destroyed by a cutworm. A simple paper collar made in "quality time" would have protected it!

Natural gardening is a rather complex subject if one wants to go about it scientifically and raise plants for peak production that way. Don't be dissuaded by the various tables in this Handbook; they can help you make Mother Earth give her very best. Natural materials, it should be added, vary considerably in their ability to provide nutrients for plants, but a surprising amount is now known about their contribution to growth.

A final note. Try to give special attention to plants suited for the spot. We know a gardener who once upon a time tore up a shady and moist border of well-nigh indestructible tawny day-lilies because they weren't quite showy enough for his tastes. Years of double digging, an ideal exercise for a weak mind and a strong back, followed in a vain attempt to grow sky-blue delphinium, summer phlox, bearded iris and other lovely first ladies of the garden. They eventually failed because they weren't adapted to the location and, in any case, had more pests than Fourth of July sparklers have sparkles! However, the soil is richer now and the gardener wiser. And day-lilies, this time in a variety of colors and bloom periods, grace the spot once again. Moral: Sometimes it's better to leave well enough alone or to improve on a theme than to tamper too much with the more-or-less natural order of things in our own gardens.

Whatever your tastes in gardening, let them bring you to a closer understanding of Nature!

Frederick McGourty, Jr.

Editor

P.S. B.B.G. Horticulturist Ed Moulin has a tip for the natural gardener whose compost pile has temporarily run out! In the autumn dig some newly fallen leaves directly into the garden. By spring most of them will have decomposed and be ready to go to work improving soil structure, especially if winter has been wet and not too cold. If you have a motor-run leaf shredder, the process can be even quicker.

People become gardeners for many reasons

GETTING STARTED IN GARDENING

Robert A. Wearne

PEOPLE become gardeners for many reasons. For some, gardening is simply a recreational (also re-creational) hobby with no particular aim. For others it may be the desire to grow a plant to its greatest ornamental beauty. Still others find maximum pleasure in raising—and savoring—garden-fresh tomatoes or sweet corn and crisp, juicy carrots. For you there may be other personal reasons.

There are also many kinds of gardens and they can be in the city, suburbs or country. If you live in a condominium or an apartment the garden site must be a patio, a balcony or a window ledge (or perhaps a shelf under artificial light) and confined to flower pots, boxes or other types of containers which can give a surprisingly bountiful crop of a favorite flower or vegetable.

If you are fortunate enough to have space outdoors, more enjoyment will be realized by placing the garden close to the house—even adjacent to the patio or terrace. This makes it more convenient to give the garden some care each day and to watch it grow, admiring the wonders of nature as the first tomato blossom gradually becomes the first garden-ripened tomato.

However, the location for the garden depends most of all on exposure. Select a place that provides all the sunshine possible. This is particularly important for vegetables. Don't plant a garden near large trees or in continuous shade, and try to avoid areas that are flooded during rain storms. If gardening is a new undertaking, for the first year think KISS—"Keep It Small and Simple."

The purpose of this Handbook is to help both new and experienced gardeners better understand some of the basic soil and cultural requirements for a successful garden. The emphasis of our contributing authors is on vegetable growing because this is a subject of great interest to home gardeners, but the fundamentals discussed here are the building blocks for any kind of gardening.

The role of organic matter in the soil has received much attention lately, and it is time to set the record straight on what it can and cannot do. Organic matter derived from leaves, grass clippings, sawdust or similar once-living material, after being composted and incorporated in the soil, becomes humus. The proper amount of humus in the soil helps provide a desirable environment for seed germination and root growth. But organic materials alone may neither contain nor provide the essential plant nutrients, such as nitrogen or phosphoric acid, in the amounts necessary for good growth and the crop of vegetables that will reward your efforts.

Similarly the various plants in the vegetable garden will remain healthy and vigorous only when protected from insects, diseases and weeds. Weeds compete with the garden plants for moisture, sunlight and nutrients and in the home garden can be satisfactorily controlled by hoeing and mulching. Actually if the weeds are eliminated in the seedling stage, the job is more like a stroll through the garden than the back-breaking task of chopping or uprooting mature weeds that comes later. Probably, next to the hoe, mulching is the best weed control.

Diseases can be kept to a minimum by growing resistant varieties, by avoiding watering at night and by applying fungicides on a timely basis as a preventive measure rather than trying to cure weakened plants.

Generally the home garden is composed of different kinds of vegetables, and each kind is relished by a different insect. A well-grown and a healthy plant may not always remain an insect-free plant. The little flea beetle soon finds the healthy eggplant, riddles the leaves and the plant becomes a sad sight, producing little or no fruit. But, when spraying or dusting for flea beetles on the eggplant, don't waste the insecticide by spraying the chard if it is insect-free!

Gardening knowledge is best acquired by experience and its value increases when shared. This sharing can be found in many books in your local library, and in information from the Cooperative Extension Service, garden centers and in the pages of this Handbook.

WHAT'S IT ALL ABOUT?

NATURAL GARDENING is common-sense gardening. It is:

• returning to the land what is taken from it, and then some. The smell and feel of good compost is as invigorating to the true gardener as salt air is to the fisherman. More important, most soils can have a better structure by the addition of compost.

• giving the soil the nourishment it needs to grow plants well. Often we can underdo it and they still do all right, but for the very best performance it is essential to know what nutrients are required, and in what amounts. It's easy to find out by an occasional soil test. A nice thing about natural gardening is that we can be as precise as we want to be.

• mulching to cut down on watering and weeding—as well as to grow plants better. True, we might have to add a little nitrogen fertilizer to curb the temporary loss of this element in the soil as the mulch decomposes and becomes humus (composting-in-place), but that's a small price to pay for avoiding a broken back. Gardening, as we sometimes stress too much, is work but it should be no more than it need be, especially on a lazy summer day when we feel like listening to the cornstalks grow.

• avoiding the use of the most toxic and persistent pesticides. This may mean more spraying with rotenone and pyrethrum—and perhaps an occasional resort to malathion or other rapidly biodegradable synthetic pesticides. We won't use the elephant gun to kill the aphid, and sometimes even a peashooter isn't necessary.

• respecting nature's approximate balances and remembering that we are but visitors on this planet. Let us not destroy what should be passed along to future generations—the Good Earth.

Recommendations that avoid dangerous pesticides

SUCCESSFUL GARDENS WITH COMMON-SENSE METHODS

Wesley P. Judkins

THE use of an organic mulch, and the selection of disease-and insect-resistant varieties, can help you have a successful garden without using dangerous pesticides. It is easy to grow healthful, delicious vegetables and beautiful flowers when such procedures are followed.

The Mulch Method of Gardening

Try this method. Plant your vegetable or flower seeds at the depth recommended on the seed packet and cover with soil in the usual way. Then spread a band of sawdust or vermiculite about 4 inches wide and one-half inch thick on top of the row. This mulch helps to conserve moisture and reduces crusting of the soil, and allows the young seedlings to emerge easily.

When the flower or vegetable seedlings are about 6 inches tall, apply a one-inch mulch of fine organic material, such as sawdust, around the plants. Do the entire garden. When leaves or another coarse mulch are used, put a 2- or 3-inch layer between the rows when the plants are about 10 inches tall. If weeds are present which are 2 inches tall or more, they should be killed by cultivating or hoeing before the mulch is applied. If weeds are less than an inch tall, they will usually be smothered by the mulch and need not be destroyed prior to its application.

Some weeds will continue to come up through the sawdust mulch. Pull these out by hand, or carefully cut them off with a sharp hoe. Weeds are easy to pull when the ground is moist after a rain. If you use the mulch method, do not cultivate because this will mix the mulch with the soil and reduces its effectiveness. Also, every time you stir the soil, weed seeds are brought to the surface where they will germinate. Therefore, whenever

Photographs by Wesley P. Judkins

Snap beans mulched with leaves—perhaps the most universally available mulching material.

A flower garden has been mulched with sawdust. With such a mulch, extra fertilizer applications will be necessary to prevent a nitrogen deficiency in the soil.

a garden is cultivated or hoed, you destroy one crop of weeds and encourage another, which must then be controlled at a later date.

When the garden is prepared for planting in the spring, the mulch should be worked into the ground by plowing, rototilling or spading. It will add organic matter to the soil and improve its structure and workability. This gives all the advantages of adding compost, plus the fact that you have had the benefit of a full season with mulch. The mulch system of gardening could be called composting-in-place. If you decide to grow vegetables this way, there will be no real need for a large compost pile.

Fertilizing the Mulched Garden

A deficiency of nitrogen may develop when large amounts of organic materials are mixed with the soil. This is caused by bacteria which decompose the organic matter, and in the process, utilize the available nitrogen in the soil. Under such conditions, the leaves of plants become light green or yellow in color.

When organic materials are used as a mulch on the surface of the soil, there usually is only a slight tendency toward nitrogen deficiency. This may be prevented by broadcasting a commercial fertilizer containing nitrogen on top of the mulch when it is plowed or rototilled into the soil. An application of 2 pounds of 10-10-10, or 4 pounds of 5-10-5 fertilizer per 100 square feet, will provide adequate nutrients for most vegetables and flowers.

If plants develop light green color during the growing season, apply a side dressing of a fertilizer containing nitrogen. Use one pound of 10-10-10 per 100 square feet, or per 50 feet of row, or use 2 pounds of 5-10-5. Spread the fertilizer uniformly between the rows of plants, and scratch into the soil or mulch with a rake. If there is no forecast for rain, water the garden thoroughly to dissolve the nitrogen and carry it down to the roots of the plants.

Some gardeners may prefer to use organic fertilizers. See pages 18 and 59.

Reducing the Need for Pesticides

The homeowner who wishes to follow organic methods exclusively can have a more rewarding garden by planting only those crops which are not susceptible to damage by pests, or by selecting resistant

In the fall or early spring, turning under a leaf mulch along with left-over vegetable plants will develop a fine organic soil.

varieties. The latter are usually described in seed catalogues, and information on them is available from your Extension Service. *(Note:* There is no conclusive evidence to indicate that crops grown organically are more resistant to damage than similar vigorously growing crops which have received commercial fertilizer.)

Although some vegetables may be severely damaged by diseases or insects, many types can be grown successfully without the use of pesticides. Some of the best crops for the home garden are asparagus, beet, carrot, celery, Swiss chard, collards, cress, endive, kohlrabi, leek, lettuce, mustard, onion, parsley, parsnip, pea, pepper, radish, salsify, spinach, sweet potato, turnip and watermelon. These may of course be damaged by diseases or insects in some seasons but, by planting only these vegetables, you can usually have a productive garden with little or no spraying. (When soil insects are troublesome, and the gardener is unwilling to use synthetic pesticides, it may be wise to avoid growing certain root crops. (See page 12.)

Some Non-Hazardous Control Methods and Materials

All home gardeners should be concerned about the use of pesticides. Some of these materials are more hazardous than others and their use should be limited to those crops which would otherwise be severely damaged by diseases or insects. A good rule to follow is to use the least toxic pesticide that will do the job.

Several non-hazardous organic or biodegradable pesticides are available for the home gardener. (For descriptions and uses, see page 10.) Our remarks here concern several mechanical and biological controls, as well as two synthetic pesticides, carbaryl (Sevin) and malathion, which are among the safest of their kind for the home garden, providing they are used in strict accordance with manufacturer's directions—as all such materials should be.

Carbaryl, best known under the name Sevin, is a man-made insecticide which is useful against a wide variety of insects. It degrades rapidly with 50 percent of its activity gone within about three days, and is completely degraded in two weeks. It exhibits no hazard to birds or animal wildlife, but is toxic to fish. Gardeners should be aware that Sevin is injurious to bees and should be used with special caution if they are present at the time of application.

Malathion, like Sevin, is effective against a wide range of insects. It has a short residual life and disappears completely in about a week. It has no adverse effect on birds and wildlife, but is toxic to fish.

Aphids are sometimes a serious pest on some garden plants. Lady beetles, available from many organic gardening supply houses, can be released to feed on aphids, but there is a chance of only temporary control because they may soon leave the area. Malathion spray is effective against several types of aphids.

Cutworms often destroy certain vegetables in the garden. Newly set cabbage, tomato, and other plants may be protected with a cardboard collar which encircles the plant one-half inch out from the stem, extending one inch into the ground and 2 inches above.

Slugs may cause damage, especially in a mulched garden which provides excellent living conditions for this pest. A ring of wood ashes or sharp sand around plants helps control slugs. Also, shallow aluminum pans sunk into the ground with the rim level with the soil and filled with beer will attract and kill slugs. They drown in the liquid.

Bacillus thuringiensis is a bacterial disease which is effective against the larvae of a number of moths and butterflies. It is useful for controlling cabbage loopers on broccoli, Brussels sprouts, cabbage, cauliflower, collards and kale.

Raising Vegetables That Have Insect Problems

Sweet corn may be damaged by borers in the ears, but this is usually confined to the tip, which can be cut away when the corn is prepared for cooking. Also, there will be less trouble if you select some of the new hybrid varieties with tight husks. All damage by corn borers can be prevented by treating the silk with mineral oil before it turns brown. This is a harmless organic compound.

Beans may be severely damaged by Mexican bean beetles unless this pest is controlled with insecticides. These pests can be controlled with malathion.

Broccoli, Brussels sprouts, cabbage, and cauliflower may become inedible because of cabbage looper. The use of *Bacillus thuringiensis* is an effective, non-pesticide method of controlling this insect.

Pumpkin and squash vines may be killed by squash bugs and vine borers. They may be controlled with Sevin.

Cucumber varieties such as 'Gemini' and 'Victory', which are resistant to several diseases, may be grown quite successfully without spraying unless cucumber beetles become a problem. Sevin will control the beetles.

Eggplants are very difficult to raise in most gardens unless the plants are sprayed to control flea beetles and Colorado potato beetles. Sevin will control these pests.

Many potato varieties are severely damaged by mosaic and late blight. 'Kennebec' is resistant to these diseases, but may need a pesticide spray if beetles become a problem. Sevin is effective against the potato beetle.

Tomato varieties are available which are resistant to fusarium and verticillium wilt and nematodes. Such varieties should be selected for the home garden. The plants may need to be sprayed to control blight.

SALTED CABBAGE

LIKE many other people, Brooklyn Botanic Garden Horticulturist Edmond Moulin began a home vegetable garden a while ago. As chief of the Garden's collection of 12,000 kinds of plants, he doesn't believe in spraying any more than is necessary to control insects and diseases, particularly when food plants are concerned. Cabbage worms were getting to be a problem on Ed's "back 40th." Vaguely recalling a home remedy his grandmother told him about 30 years ago on a farm in northeastern Connecticut, he gave her a call to get the details. "Sprinkle coarse kosher salt down among the leaves when you see the worms," she advised. Ed did, three times early in the growing season, and that was the end of them. The outer leaves were a bit dry due to the interaction of rain and salt, but the taste of the cabbage couldn't have been better, he reports.

New developments and old-time practices for the natural gardener

GARDEN PEST CONTROL WITHOUT SYNTHETICS

Arthur H. Retan and Horace Telford

MOST OF US remember when reasonably good gardens could be grown with little or no use of insecticides. While a number of pests now encountered are recent imports from other countries, for the most part we face the same insect pest complex found in pre-DDT days. Fortunately, a few recent nonpesticide approaches to insect control have been developed. These new developments combined with many old-time practices make it possible to obtain a reasonably insect-free garden without the use of synthetic insecticides.

Our recommendations are aimed particularly toward the home vegetable grower but also apply to the gardener interested mainly in ornamental plants. Whatever your interests, if you are part of the growing number of gardeners who would like to raise plants without using synthetic insecticides, your success and enjoyment will be greater if you heed the following suggestions:

1. Avoid or limit the growing of highly insect-susceptible plants.
2. Be willing to accept a certain amount of insect damage.
3. Prepare to work harder to achieve control.
4. Plant and care for a larger garden than normal to obtain a yield that will offset insect losses.
5. Expect considerable damage from several soil insects and from codling moth on apples and pears. There are no satisfactory controls for these pests unless modern synthetics or the older arsenicals for codling moth and fumigants for soil pests are used.

Within these limits it is possible to have a personally satisfying garden without using synthetic insecticides. However, some spraying or dusting will likely b necessary. The insecticides mentione here are not synthetics but are low-hazar materials derived from plants, dorman and summer petroleum oils, and lime sulfur and elemental sulfur.

Plant-derived Insecticides

Pyrethrins. These insecticides are derive from the dried flowers of certain specie of chrysanthemum including *C. cinerani folium,* and have been used for control ling insects since ancient times. The have the property of "quick knockdown" and very short residual effects. There fore, they must be used often. They ar sold most frequently with an activator o synergist (piperonyl butoxide, piperony cyclonene, or some other synergist) Pyrethins without these safe activator would be much less effective, difficult t obtain, and almost prohibitive in cost Allethrin, an insecticide chemically simi lar to pyrethrins, has also been developed

The pyrethrins kill insects only by con tact. They are effective against a wid range of garden pests especially the soft bodied forms, but will not control mites Do not spray around fish ponds. Con sult the label for specific usages. Fruit and vegetables which have been spraye can safely be eaten soon after applica tion, but read and follow the label care fully.

Rotenone. For centuries Africans, South Americans and others living in warn areas have used this plant derivative as a fish poison. Fortunately, although rote none is highly toxic to most cold-bloode animals, it is very safe for most warm blooded types, including man. In th tropics a powder is made from *Derri*

The flowers of *Chrysanthemum cinerarifolium* in the Brooklyn Botanic Garden Herb Garden. The dried unexpanded flower heads of *C. cinerarifolium* are a source of the Dalmatian insect powder pyrethrum. Several other daisies have also been used in making insecticides.

Brenda Weisman

elliptica and related species, members of the Legume Family containing rotenone. The material, which contains a toxic chemical, is then placed in lakes or streams to kill fish. They die quickly and can then be eaten.

In the mid-19th century, rotenone's properties as an insecticide were discovered and it became widely used until the mid-1940's, when DDT and other synthetics largely replaced it. It has longer residual action than the pyrethrins, but also requires repeated applications. Rotenone is probably the best general-purpose, non-synthetic garden insecticide available. It can be used either as a dust or spray and kills a wide range of garden insects such as caterpillars, aphids, and certain beetles, but is ineffective against spider mites and soil insects. Read the label carefully for specific usages.

Nicotine. This old-timer unfortunately controls only aphids, related soft-bodied sucking insects, thrips, and a few species of caterpillars. It does not control most chewing insects. It is derived from the tobacco plant and is usually sold as a 40 percent liquid concentrate of nicotine sulfate (Black Leaf 40) which is then diluted with water and applied as a spray. Nicotine dusts are not normally sold for backyard use because of the irritation to the operator. Nicotine is much less effective when applied during cool weather. It has short residual effects and can be used on vegetables very close to harvest. Nicotine concentrate is extremely poisonous.

Oils and Sulfur

Dormant and Summer Oils. Petroleum oils have been used for insect control as early as 1787 and are still popular, although not used as extensively as they might. Apply them only on woody plants. There are two principal types: the dormant oils, which should only be applied on trees or shrubs which are in a dormant or delayed-dormant condition; and summer oils, which can be used during the growing season, but are also restricted to woody plants.

To apply a strictly dormant oil during the growing season will cause severe foliage burn. For summer use, be certain to purchase oil especially prescribed for this purpose and apply only on those plants for which the material is recommended. There are some special oils which can be applied in either summer or winter; however, the concentration used in summer is far less.

Oils control many insects and their eggs, such as overwintering leafrollers, and aphid and mite eggs, as well as nymphs and adults of aphids, scale insects, and mites. These oils must first be diluted with water. They contain emulsifying agents which facilitate their mixing when added to water. The oils cause little or no harm to most beneficial insects. Also, resistance of pests to these sprays does not occur. They are nonhazardous to human health.

Lime-Sulfur (Liquid). This old-timer is still in commerical use. It is used much the same way as for the dormant oils diluted with water. Do not apply to apricot trees at any time, since it may result in foliage injury. Use only on woody plants and only during the dormant season, or up to prebloom on some plants. The only exception is on raspberries and other cane fruits, where it can be used for dryberry and redberry mites in the spring when leaf buds are ½ inch long. This material is particularly effective against pearleaf blister mites, rust mites, and their close relatives, as well as for many insect eggs.

Lime-sulfur sprays also have fungicidal value. For use on fruit trees they are often mixed with dormant oil to increase its efficiency. Apply lime-sulfur with caution when ornamental plants are treated near the house. The spray drift when dried is most difficult to remove from buildings, and may cause stains on all types of painted surfaces.

Elemental Sulfur. This finely ground powder can be applied either as a dust or spray. In addition to controlling fungus diseases, it will also control spider mites, especially during hot weather. Warning: do not use sulfur on most vegetables just prior to harvest if you plan to can the produce. Small amounts of sulfur in the can will produce sulfur dioxide which will cause the container to explode. It may also cause off-flavor. Sulfur can be used safely on berries and other fruits without these hazards, and on vegetables eaten fresh, dried, or processed for freezing. Sulfur is very safe—in fact it is an element essential for good health.

Soaps as Insecticides. Soap diluted with water has been recommended for certain soft-bodied insects, such as aphids, since 1787. Most often these soaps were derived from either plants (coconuts, olive, palm, cottonseed) or from animal fat, such as whale oil, fish oil, or lard. Vegetable or plant-derived soaps are more effective than those derived from petroleum. Unfortunately, commercial soaps vary tremendously in composition and purity, hence in effectiveness.

A homeowner might try soap suds from a known brand of inexpensive laundry soap against aphids on a limited scale first. Should this prove successful, the practice could be extended. Or some old-fashioned homemade soap may be prepared using inexpensive waste lard or tallow, lye, water and borax (optional). Six pounds of fat and a can of lye will make six pounds of soap. For directions, obtain the bulletin Making Soap in the Home (E.M. 3378, 1970) from your county Extension office.

Other Approaches to Insect Control

Many cultural practices, including adequate fertilizing and watering, can help reduce the susceptibility of plants to insect attack. First, rotate the vegetable plot if you possibly can. However, if you have just a small piece of land and this isn't feasible, you can at least change the sequence of plants within the garden from year to year. In addition, use interplantings (as opposed to solid plantings of a given species) to isolate infestation and reduce damage. Also, it is best not to plant a garden on recently plowed sod.

Too many insect-susceptible vegetables are a special invitation to trouble for gardeners who don't care to use synthetic pesticides. Unfortunately, soil insects can be effectively controlled only by the synthetics. Among these pests are white grubs, wireworms, cabbage maggots, onion maggots and carrot rust flies. Should your plot develop a soil insect problem, such as wireworms or white grubs, avoid growing potatoes, carrots and other root vegetables. Also, you should be aware that the cole crops, which include radishes, cauliflower, cabbage, broccoli and turnips, are highly prone to attack by both foliage insects,

Molly Adams

A shipment of ladybugs. They are being released in a home garden to devour aphids.

particularly the cabbage worm, and by cabbage maggots in the soil. Give greater space to the more insect-tolerant vegetables, such as beans, peas, chard and spinach.

Handpick pests when practical. Flick them from the leaves into a bucket containing a mixture of water and kerosene or oil. Also, the gentle spray of water from a hose helps keep down certain insects. The careful, regular inspection of a garden can be an invaluable aid in curbing outbreaks before they appear.

Use transplants. The longer a plant is growing in a garden, the greater is its exposure to potential insect attack. For this reason, plants of the cabbage family will avoid early and often devastating attacks of cabbage maggot if you purchase healthy, mature transplants or else grow them under glass or in the home for transplanting outdoors later. A healthy transplant will more likely overcome subsequent insect attack than a small plant developing from seed in the garden. In either case, it is often desirable to use hot caps during the early growing season outdoors. They not only preserve heat and prevent wind and hail damage, but also minimize early insect attack.

Good sanitation is important. Since many garden insects overwinter in plant debris, spade under old plants, including spinach, lettuce and other early-season vegetables, during the summer, or add them to the compost pile. The cabbage aphid, for example, may over-winter as an egg on the cabbage plant which has been left in the garden; the adult asparagus beetle persists in the hollow stems of asparagus that has not been cut to the ground in autumn; and several species of leafhopper overwinter in or on plant debris. Immediately dispose of culled onions because the onion maggot will continue to breed in them. Manure and compost are valuable additions to garden soil, but too much can encourage millipedes, white grubs and other pests.

Keep your garden free of weeds and volunteer plants: these can harbor pests—particularly certain aphids which may transmit disease organisms. In addition, cultivating a garden exposes those stages of pests which live near the surface of the soil to birds and injuries or kills some insects. Cultivation in autumn is especially beneficial since it also exposes pests to the rigors of winter.

Other methods are mentioned from time to time. There is much publicity now on the use of light traps, reflective materials such as aluminum foil, irradiation, electric shock, repellents, and the use of sex hormones. None of these methods can be recommended for the homeowner at the present time, although some may eventually be of value.

Biological Control of Insect Pests

Biological control is the use of any form of life to control a pest. A controlling agent may be a disease organism, a predacious or parasitic insect, predacious spiders and mites, insect-feeding birds, rodents, toads, or other vertebrates. A number of companies now supply insect and mite predators and parasites to gardeners and farmers. For a current and complete listing, refer to any magazine on "organic" gardening. Many of these beneficial organisms occur naturally, but effective numbers often develop too late to control the pest before severe damage occurs.

One must keep in mind also that when an insect is introduced to prey upon or parasitize a certain pest, its numbers can only be increased in nature if it has sufficient prey to feed upon. If your plants are experiencing little insect damage or the pest species are in low numbers or absent, the beneficial insects or other animals must move elsewhere, where food is available for their survival. To allow prey insects or other animals that feed on pests to increase in number sufficiently to control pest insects, you must expect a certain amount of damage to plants. You can't have insect-free garden produce and encourage beneficial insects at the same time.

The insecticides mentioned in this article are definitely less hazardous to beneficial insects (e.g., lady beetles) than many of the synthetic pesticides, but they should be used only when absolutely necessary in order to preserve as many beneficial forms as possible.

Encouragement of Birds

Birds are far more important in preventing insect outbreaks than in controlling them. All birds feed upon insects to some degree. The flycatchers, swallows, warblers, vireos, creepers, nuthatches and woodpeckers are almost entirely insectivorous, while blackbirds, robins, crows, gulls, magpies and even the birds of prey, the hawks and owls, commonly feed on insects. To develop numbers of birds near gardens one must encourage those species which feed largely upon insects. If all species are encouraged, including starlings, blackbirds and others which damage small-fruit or vegetable gardens, you may be asking for trouble.

Insect-feeding birds can best be encouraged by providing cover, supplementary feed, and protection from cats and other predators. Information on the encouragement and protection of insectivorous birds may be obtained from the U.S. Fish and Wildlife Service. Additional information on bird houses, feeders, etc. can be obtained from the publications *Bird Attracting* (National Audubon Society, 950 3rd Avenue, New York, N.Y. 10022, $1.50) and *Homes for Birds*, USDA Fish and Wildlife Service Conservation Bulletin 14, (Supt. of Documents, U.S. Gov. Printing Office, Washington, D.C. 20403, 20 cents).

Two books on the subject are also available: *Gardening With Wildlife*, National Wildlife Federation, 1412 Sixteenth Street, N.W., Washington, D.C. 20036 ($12.95); *American Wildlife and Plants: A Guide to Wildlife Food Habits*, Dover Publications, Inc., 180 Varick Street, New York, N.Y. 10014 ($3.95 paperback).

Plants require 16 elements for proper growth and development

NUTRIENTS NEEDED BY PLANTS

John F. Trierweiler and James D. Utzinger

ADEQUATE NUTRITION is essential for plant growth and development, the same as it is for animals and humans. A basic nutritive product of crop plants is carbohydrate. Carbohydrates are produced as a result of photosynthetic activity in the green tissues of plants. Once carbohydrates are available, other essential plant products are formed. They include fats and oils, proteins, vitamins, hormones, enzymes, pigments and related materials.

Sixteen chemical elements are the key to the development of all important plant products. Plants cannot complete their life cycle if any of the 16 elements are lacking. Three of them, carbon, hydrogen and oxygen, are obtained from water and the atmosphere. The other 13 are important to plant nutrition in varying quantities. For example, nitrogen, phosphorus and potassium, often referred to as primary nutrients, are required in relatively large quantities. Unfortunately, these important nutrients often are not present in adequate supply in many garden soils.

Calcium, magnesium and sulfur, the so-called secondary nutrients, are also necessary for plant growth and development, and are required in about the same amounts as phosphorus. In properly limed soils, secondary nutrient elements seldom limit growth.

Needed in smaller, often trace amounts, are seven essential nutrient elements commonly called micronutrients. These micronutrients—boron, copper, iron, manganese, molybdenum, iron and zinc—are of vital importance in plant physiological processes. Most soils having a pH range of 5.5-7.0 contain adequate amounts of micronutrients in a form available to plants.

Since the sources of carbon, hydrogen and oxygen are air and water, there is little control over their availability except through drainage, irrigation and modification of the physical condition of the soil. Chemical analysis reveals that most fresh plant tissue is composed of carbon, hydrogen and oxygen. The other 13 elements combined account for only 0.5 to 6.0 per cent of the plant dry weight. However, when a nutrient deficiency limits growth or reduces product quality, it is usually one or more of the 13 elements that is lacking. The supply of these 13 elements in the soil is adjusted by fertilizer and lime applications, as indicated by soil test results.

Soil Reaction and Nutrient Availability

If the essential plant nutrients are to be available for plant absorption and use, they must be in a chemical form that can be absorbed by the plant roots. Also, nutrients must be in the right proximity in the soil to the absorbing root surface, and they should be present in the proper proportions (i.e., not all nitrogen). Therefore, the capacity of the soil to provide essential elements not only depends upon the supply of nutrients in the soil, but also upon the location and form in which the nutrients are found.

Soil reaction plays a very important role in the availability (form) of plant nutrients (see Figure 1). In medium to strongly acid soil (pH 4.0-5.5) nitrogen, phosphorus, potassium, sulfur, calcium, magnesium and molybdenum are less available to plants. In alkaline soils (above pH 7.0), iron, manganese, boron, copper and zinc are less available and may limit plant growth. (See Figure 2.)

Many soils east of the Mississippi River are acid by nature. However, home garden soils often have been altered considerably from their native state as a re-

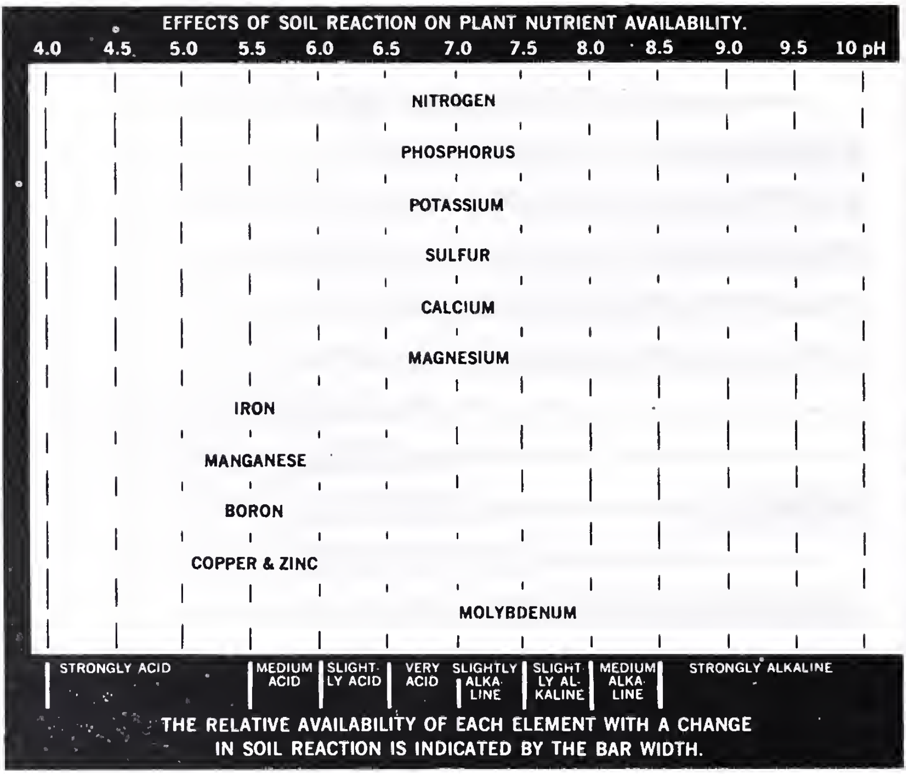


Figure 1

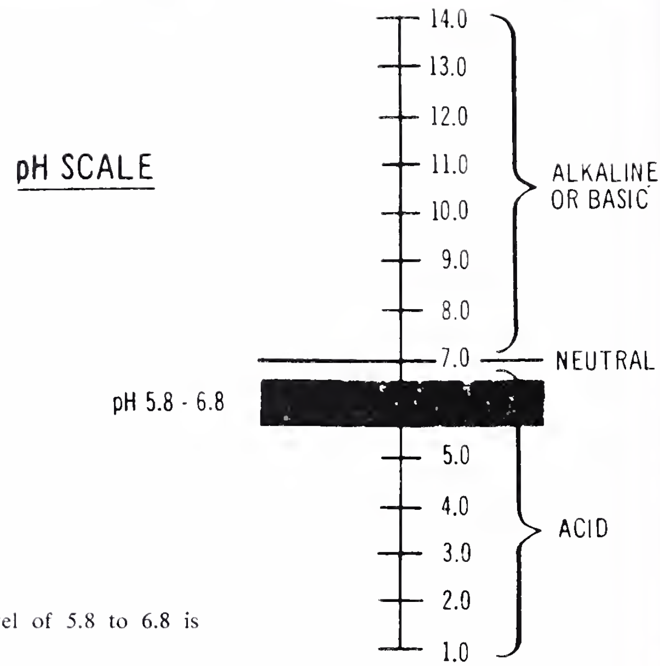


Figure 2 A soil pH level of 5.8 to 6.8 is best for most crops.

sult of grading and leveling by earth movers as well as by cultural practices.

The addition of lime to acid soils supplies calcium and some magnesium, and it reduces harmful concentrations of aluminum, manganese and iron. In addition, liming acid soils increases favorable microbial activity, accelerates the release of nutrients from organic matter and improves soil structure and tilth.

Some plants, such as rhododendron, azalea, blueberry and dogwood, require an acid soil (pH between 4.5 and 6.5). Soil acidity for them in non-acid soils is increased by the addition of sulfur to the soil.

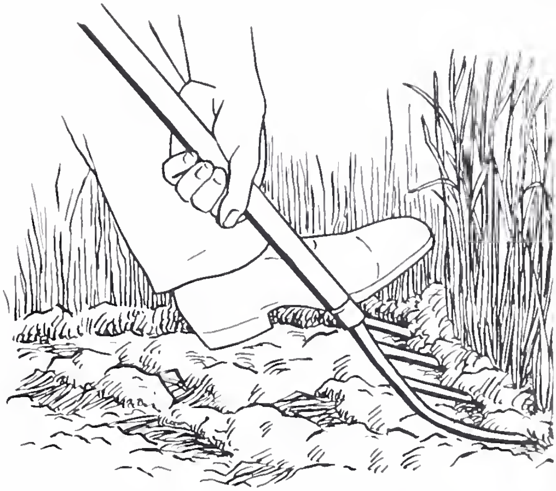
Nutrients from Fertilizers

If soil test or foliar analysis results indicate that nutrients are deficient in the soil, the supply can be replenished by adding organic or inorganic fertilizers. Nearly all of the nutrients utilized by plants are taken up in inorganic form and plants cannot distinguish between the original organic and inorganic sources of these nutrients. Thus, it does not make any difference whether the nutrient ions originate from the biological decomposition of organic substances or from dissolved inorganic fertilizers. In fact, nutrient elements are normally absorbed by the root system only in the inorganic form. In this regard then, both organic and inorganic fertilizers have some advantages in plant growth.

Organic Fertilizers

The term "organic" can be rather confusing, since it refers not only to products from living organisms, but also to all compounds containing carbon, many of which do not even exist in living organisms. In addition to the many thousands of new organic compounds chemists have synthesized, they have also synthesized many of the same compounds which living organisms produce. These artificially produced compounds are exactly like the natural compounds.

Generally, organic fertilizers, such as blood and bonemeal, animal manure and peanut hulls, are less likely to burn plant tissue than are inorganic fertilizers. Also,



Eva Melady

Bulky organic materials, especially green manure crops, are valuable in the soil.

due to their composition, organic fertilizers help improve soil structure and tilth. In the case of some organic materials of a bulky nature, the soil-improving effect often is more valuable than the nutrient elements contributed to the soil. Bulky organic materials, either composted or used as green manure crops, are quite valuable for soil improvement, both from the structural and fertility standpoint.

Animal manures are similar in value to organic fertilizers derived from plants or plant residues, even though their composition is somewhat different. Their high moisture percentages and ideal physical and chemical conditions for further biological decomposition cause them to degrade rapidly. Because nitrogen and other elements may be quickly leached, careful management is required when using animal manure for the improvement of soil fertility.

Sometimes when extremely large amounts of animal manures containing nitrogen are applied to soils, plant growth may occur at the expense of flowers and fruits. When vegetables, fruits or garden flowers are grown, the balance between vegetative and reproductive development will be critically affected by the nitrogen level in the soil.

Some nutrient elements from organic

fertilizers are released slowly. Their use requires early and continued applications so that the proper amounts of nutrients are available when the plants need them.

Another important dimension of using organic materials, particularly fresh or only partly decayed ones, is that of possible temporary plant nitrogen deficiency. If large amounts of residues high in carbon, or ones only partly decomposed, are incorporated into the soil, they are best accompanied with supplemental nitrogen. (See Table on page 18.) Suggested applications are ¼ pound of ammonium nitrate or $^{2}/_{5}$ pound of ammonium sulfate for each bushel of mulch used on the garden or 2 pounds per 100 square feet of a complete fertilizer such as 12-12-12, 15-15-15 or similar analysis where mulch is to be applied to the soil surface. Table 1

TABLE 1. Primary Nutrients Contained in Organic Fertilizers
(Average Analysis of Fertilizers Without Losses from Leaching or Decomposition)

	Nitrogen* (% N)	Phosphorus* (% P_2O_5)	Potassium* (% K_2O)
Bulky Organic Materials			
Alfalfa Hay	2.50	.50	2.10
Alfalfa Straw	1.50	.30	1.50
Bean Straw	1.20	.25	1.25
Cattle Manure (fresh)	.55	.15	.45
Cottons Bolls	1.00	.15	4.00
Grain Straw	.60	.20	1.10
Hog Manure (fresh)	.50	.35	.45
Horse Manure (fresh)	.65	.25	.50
Olive Pomaces	1.20	.80	.50
Peanut Hulls	1.50	.12	.78
Peat and Muck	2.30	.40	.75
Poultry Manure (fresh)	1.00	.85	.45
Sawdust and Wood Shavings	.20	.10	.20
Seaweed (Kelp)	.60	.09	1.30
Sheep Manure (fresh)	1.05	.40	1.00
Timothy Hay	1.02	.20	1.50
Winery Pomaces	1.50	1.50	.80
Organic Concentrates			
Animal Tankage	9.0	10.0	1.5
Bat Guano	10.0	4.5	2.0
Bone Charcoal and Bone Black**	1.5	32.0	.0
Bone Meal	4.0	23.0	.0
Castor Pomace	6.0	1.9	.5
Cocoa-shell Meal	2.5	1.5	2.5
Cottonseed Meal	6.0	2.5	1.5
Dried Bloodmeal	13.0	1.5	.8
Dried Cattle Manure	2.0	1.8	2.2
Dried Sheep and Goat Manure	1.4	1.0	3.0
Fish Meal	10.0	6.0	.0
Fish Scrap	5.0	3.0	.0
Garbage Tankage	2.5	1.5	1.5
Hoof and Horn Meal	12.0	2.0	.0
Sewage Sludge	3.0	2.5	0.4
Soybean Meal	7.0	1.2	1.5
Steamed Bone Meal	.8	30.0	.0
Tobacco Dust and Stems	1.5	.5	5.0
Wood Ashes**	.0	2.0	6.0
Wool Wastes	7.5	.0	.0

* Based on dry weight except for the fresh manures which contain about 65 to 85% water.
** Burning eliminates organic matter and forms inorganic compounds.

provides information about the nutrient element content of several selected organic fertilizers.

Inorganic Fertilizer

Inorganic compounds include all compounds which are not organic and overlap to include some of the simple carbonaceous compounds like the carbonates. Many inorganic fertilizers, such as various phosphate and potassium salts, occur naturally in deposits laid down by nature many years ago. In fact, nature was forming inorganic fertilizers long before any life existed on earth.

Table 2 lists a number of principle inorganic fertilizers from which mixed fertilizers are usually formed. The inorganic fertilizers, which are commonly available in garden supply stores, are often blends such as 12-12-12, 5-10-5 and 5-20-20. Many fertilizers in Table 2 also contain varying amounts of calcium, magnesium and sulfur.

Commercial fertilizers are labeled to show the content of elemental nitrogen (N), available phosphate (P_2O_5) and water-soluble potash (K_2O). Ammonium nitrate, a nitrogen fertilizer which is 33.5 percent N will be labeled 33.5-0-0, while potassium chloride, a potassium fertilizer which is 60 percent K_2O, will be labeled 0-0-60. Mixed fertilizers are labeled to show the content of nitrogen, phosphate and potash *always in that exact order* and guaranteed analysis. A 12-4-8 mixed fertilizer contains 12 percent N, 4 percent P_2O_5, and 8 percent K_2O. In other words, a 100-pound bag of 12-4-8 contains 12 pounds N, 4 pounds P_2O_5, and 8 pounds K_2O. The balance of the weight consists of chemical compounds carrying the nutrient elements and materials that have been added to prevent caking and to improve "flowability" of the fertilizer.

Phosphorus fertilizers such as superphosphate are generally less likely to burn plants than are either nitrogen or potassium fertilizers. However, normal care in applying any fertilizer will avoid damaging plants.

TABLE 2. Primary Nutrients Contained in Inorganic Fertilizers

Fertilizer	Formula	Nutrients Available Nitrogen (% N)	Phosphorus (% P_2O_5)	Potassium (% K_2O)
Ammonium Nitrate	NH_4NO_3	33.5	0	0
Ammonium Sulfate	$(NH_4)_2SO_4$	21	0	0
Calcium Nitrate	$Ca(NO_3)_2$	16	0	0
Nitrogen Solutions	(Varies)	20-50	0	0
Sodium Nitrate	$NaNO_3$	16	0	0
Urea	$CO(NH_2)_2$	45	0	0
Ammonium Phosphate	$NH_4H_2PO_4$ mostly	11	48	0
Diammonium Phosphate	$(NH_4)_2HPO_4$	18	46	0
Basic Slag	Ca, Mg, Al silicates high in phosphates	0	8	0
Rock Phosphate	$3Ca_3(PO_4)_2.CaF_2$ mostly	0	5	0
20 percent Superphosphate	$CaH_4(PO_4)_2$ and $Ca_2H_2(PO_4)_2$	0	20	0
Concentrated Superphosphate	$CaH_4(PO_4)_2$	0	45	0
Superphosphoric Acid, Polyphosphate	H_3PO_4 and $H_4P_2O_7$	0	76	0
Green Sand (Glauconite)	$KFeSi_2O_6.nH_2O$	0	1	6
Muriate of Potash	KCl	0	1	6
Potassium Sulfate	K_2SO_4	0	0	50
Magnesium Sulfate	$MgSO_4.mH_2O$	0	0	21
Potassium Nitrate	KNO_3	13	0	44

Although the home grower can usually secure sufficient organic fertilizer to have a good garden, a balanced fertilizer program, using both organic and inorganic fertilizers, is generally best. In this manner, the organic fertilizers can accelerate soil improvement by adding additional organic matter, while inorganic fertilizers increase the needed nutrients quickly and efficiently.

Further Reading

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HOW TO PRICE FERTILIZER

WHEN cost is a factor in purchasing fertilizer, the bag analysis enables the gardener to calculate the price per pound of nutrient and make the best buy. If, for example, dry cattle manure has a bag analysis of 1-1-1 and cost $3 for a 50-pound bag, the total nutrient content is 1/2 plus 1/2 plus 1/2, or 1-1/2 pounds. The cost is $3 divided by 1-1/2 pounds, or $2 per pound of plant nutrient. A 10-10-10 mixed fertilizer which costs $4.50 for a 50-pound bag has 5 plus 5 plus 5 or 15 pounds of nutrients in the materials. The cost is $4.50 divided by 15 pounds, or 30 cents per pound of plant nutrient.

If a fertilizer recommendation calls for 1 pound of nitrogen (N), 1 pound phosphorous (P_2O_5), and 1 pound potassium (K_2O) per 1,000 square feet and the garden is 2,000 square feet, then 2 pounds N, 2 pounds P_2O_5 and 2 pounds K_2O are needed for the garden. Four 50-pound bags of a 1-1-1 manure would supply the necessary nutrients. However, 20 pounds of a 10-10-10 would be equally good at supplying them. The cost for manure would be 4 times $3, or $12, while the cost for the 10-10-10 fertilizer would be 20/50 times $4.50 equals $1.80. The gardener needs to take into account the economics of fertilizer usage along with other considerations for most effective results.

Molly Adams

How it works in the soil

SOURCES OF ORGANIC MATTER

Wilfred H. Erhardt and Lyle Littlefield

Organic matter is the life of soil. On heavy soils (silt loams and clays), organic matter acts as a cementing agent by binding fine soil particles together into aggregates. As a result, excess water normally held by heavy soils is allowed to drain free. Such soils supplied with organic materials will warm up more rapidly in the spring and become workable more quickly than those lacking these materials. Conversely, on light soils (sandy loams and sands), organic matter fills in the excess pore space, slowing down drainage and increasing their water- and nutrient-holding capacity.

Although organic matter is valuable for soil improvement and generally does supply nutrients, it does have limitations. Contrary to the belief of some gardeners, organic matter, per se, will not prevent insect and disease injury. Large additions of organic materials prior to planting of beans and peas may lead to seed damage by the seed corn maggot. Furthermore, organic materials alone are not balanced sources of plant nutrients, since some contain little or no readily available nutrients and others are low in phosphorus. Since organic materials are not balanced, they should be supplemented with plant food nutrients such as phosphorus and nitrogen.

Prime Sources of Organic Matter

Organic matter may be added to soils from many different sources, but all these sources originate from either plant or animal organisms. The most important sources of organic matter are those materials that are valued for soil improvement rather than for plant nutrient content. All organic materials should be spread evenly on the soil and tilled or forked into the soil as deeply as possible in autumn or early spring. For spring application, use materials that are well-rotted and rather fine in texture to facilitate easy seedbed preparation.

Animal Manures—Livestock manure is an excellent source of organic matter and is still widely available outside of urban areas. Nutrient content of manures varies widely. Since fresh manure is low in phosphorus, rock phosphate, at the rate of 1½-3 lbs. (1-3 pts.) per bushel of manure, should be added. Use 500 to 1,000 lbs. (15-30 bushels) of cow, hog or horse manure per 1,000 sq. ft. Poultry, sheep, goat and rabbit manures should be used at half this rate because of their higher nutrient content.

For utilization of dried manures, which are usually available in garden centers, consult rates of application on package label. In most rural areas animal manures are becoming a real disposal problem for livestock producers and riding stable proprietors, and large quantities are usually available at a minimum charge or often can be hauled away free.

Compost—A compost consists of one or more organic materials that have been piled and allowed to decompose to a point where the product breaks up readily and can be worked into the soil easily. Compost consists mainly of decaying materials such as leaves, kitchen and table scraps and weeds, but can include animal manures, tankage, sawdust or whatever is available locally.

Diseased plant materials and weeds that have gone to seed should not be added to the compost heap. Discard them because some diseases and weed seeds will survive the composting process.

Green Manure—Green manure refers to those plants grown especially to be forked or tilled under for soil improvement. They include alfalfa, clovers, buckwheat, millet, rye and ryegrass. To improve soils low in organic matter, a green manure crop such as alfalfa and clover can be grown and turned under after one or two years of growth.

A cover crop, which is a green manure crop that is normally seeded in autumn, allows a person to use the garden in the summer and still add organic materials the following spring. Cover crops (annual ryegrass and winter rye) add organic matter, protect soil from winter erosion, and reduce leaching losses by utilizing excess nutrients, especially nitrogen.

Vegetative Residues—Leaves, grass clippings, and other naturally occurring vegetative residues are excellent sources of organic matter. Certain organic materials such as peat moss, sawdust and kelp are employed primarily to improve the physical properties of soils. Peat moss can be used in establishing new lawns, gardens and flower beds. Rate: 1/3 to 1/2 cubic yard of loose peat or 1/2 to 1 compressed bale (6 cubic-foot size) for each 100 sq. ft. This equals a surface application of 1 to 2 inches of peat. If dry peat is mixed into the soil, water the mixture thoroughly and allow it to settle before planting.

Sawdust, leaves and hay are vegetative-residue materials with high carbon-contents in relation to their nitrogen content. When these residues are applied

TABLE 1. ORGANIC MATTER OF VARIOUS CARBON-NITROGEN RATIOS

Organic Matter low in carbon, high in nitrogen (a very narrow ratio)	Organic Matter high in carbon, high in nitrogen (a narrow ratio)	Organic Matter high in carbon, low in nitrogen (a wide ratio)	Organic Matter very high in carbon, low in nitrogen (a very wide ratio)
Liquid Manure (10:1) Humus (10:1) Legumes, e.g. Alfalfa and Clovers, in early stages of growth (15:1-20:1)	Legumes in late stages of growth (20:1) Non-legumes in early stages of growth (20:1)	Rotted Straw and Rotted Leaves (60:1) Non-legumes in late stages of growth (60:1)	Straw (80:1) Stubble (80:1) Strawy Manure (80:1) Leaves (80:1) Sawdust (400:1)

to a moist, warm soil, they start to decompose through the action of microbes. The microbes require energy and a source of available nitrogen, which many of the vegetative residues have only in small amounts. These microbes take nitrogen from the soil at the expense of a growing plant. Unless the soil is exceedingly well supplied with nitrogen or a supplementary addition of a nitrogen source is made, the plant will suffer a nitrogen deficiency. To avoid this problem, apply 2.0-2.5 lbs. (1.5-2.0 pts.) of dried bloodmeal for each tightly packed bushel of high carbon, low-nitrogen vegetative residue material (sawdust, leaves, etc.).

Organic plant foods provide "natural" gardens with relatively high sources of a given nutrient. However, in general, organic plant foods are not intended to be used for soil improvement. These materials are used in relatively low volumes and are rather expensive per unit volume. See table on page 18.

Animal Tankage—Tankage is the rendered, dried and ground by-product, consisting largely of animal meat and bone. Tankage-derived plant food includes dried bloodmeal, fish scrap, hoof and horn meal, steamed bonemeal as well as other products. Of these bloodmeal and bonemeal may be considered the most readily available sources of nitrogen and phosphorus, respectively. Dried bloodmeal, a nitrogen source, can be sidedressed to supply additional nitrogen later in the growing season. Application of 6-10 lbs. (2.5-4 qts.) per 1,000 sq. ft. in small furrows 3-4 inches away from plant stems and 2-3 inches deep stimulate growth.

Processed Vegetative Residues—This group includes wood ashes, soybean meal, cottonseed meal and castor pomace. Most are by-products of industrial processes. Since they are generally sources of nitrogen (5-7%) and contain only small quantities of other plant nutrients, these materials could be considered as sources of that element.

Sewage Sludge—Sludge is a byproduct from the purification of city sewage. Sewage is essentially waste materials from domestic and industrial sources and can contain a wide array of animal, vegetative and mineral materials.

Dried digested sludge and dried activated sludge have been used in much the same fashion as animal manures. Dried digested sludge material, not heat treated, should be used with some caution because of the possible presence of pathogenic organisms. If it is used on plants, it should be incorporated into the soil several months (3-6) before plants are grown. On the other hand, dried activated sludge material that has been heat treated is normally safe for use and free from pathogenic organisms.

"And, Miss Jones, call out for a pound of tankage."

Science has an answer

COMPANIONATE PLANTINGS—DO THEY WORK?

S. G. Gessell, Robert J. Precheur and R. W. Hepler

In recent years a growing number of people have expressed concern over the widespread use of pesticides on our food crops and have suggested different ways to raise them without resorting to the synthetic chemicals for curbing insects. One such method often mentioned in books, garden club meetings and in the press is companionate planting—the theory being that certain kinds of plants will specifically prevent pest damage to certain other kinds of plants when grown nearby.*

The scientific literature does not disclose any data on this kind of pest control. Therefore, a study was designed at Pennsylvania State University to obtain facts on the effectiveness of six plant species in preventing damage by particular insect pests when planted each as a companion to six common vegetables.

How We Proceeded

The plants selected for this test were: (1) Radish ('Early Scarlet Globe') with cucumber ('Pioneer') to protect the plants from striped cucumber beetles; (2) Snap beans (Bush 'Blue Lake 274') with potatoes ('Katahdin') to protect the potatoes from Colorado potato beetles; (3) Onion ('Ebenezer') with carrots ('Royal Chatenay') to protect carros from rust fly and leafhoppers; (4) Marigolds with snap beans (Bush 'Blue Lake 274') to protect bean plants from Mexican bean beetles; (5) Thyme with cabbage ('Market Prize') to protect cabbage from imported cabbage worms; and (6) Catnip with eggplant ('Penn Beauty') to protect the eggplant from flea beetle damage.

The plot size was one row, 30 feet long with a spacing of 10 feet between each plot. To decrease the chance for error, a standard scientific procedure called replication was followed. Briefly, three identical plantings—or replications—were laid out in a randomized block design.

The close planting treatments for each of the six combinations had companion plants dispersed closely in the row and never over 2 feet apart. The loose planting treatments had the companion plants at the 2, 9, 16, and 23-foot marks in the row. The check plantings, essential in all such experiments, contained no companion plants.

The plots were planted on May 24 and 25, 1972, except for the thyme plants, which were transplanted to the field on May 30, 1972. All weeding was done by hand or mechanical methods. No pesticides were used at any time on the plots.

1. *Radish with Cucumber:* Seeds were placed in the furrow at approximately 8-inch intervals, providing a potential of 45 plants per plot. The striped cucumber beetle was the only insect pest of any importance that attacked the cucumber plants. This species appeared in abundant numbers as soon as the plants cracked the soil and continued at fairly high levels of one to three per plant as long as the plants remained alive. Many of the plants were killed outright as a result of the feeding of the adult beetles on the foliage, some plants were killed due to root and stem feeding of the larvae and beetles while others gradually died from cucurbit wilt disease.

* *Ed.* A frequent, and incorrect, attribution of successful companionate planting is given to marigolds because of their ability to repel nematodes in the soil. Actually, marigolds have this effect regardless of what other kind of plant they are grown near.

TABLE 1. Grade assigned cucumber plants and number of living plants as a result of striped cucumber beetle feeding.

Treatment and date	No. of living plants	% of plants in grade 1	2	3	4	5	No. of plants bearing fruit
June 19		Replicate I					
Close planting	26	0	7.7	53.8	23.1	15.4	—
Loose planting	14	0	14.3	57.1	21.4	7.2	—
Check	40	0	25.0	42.5	25.0	7.5	—
		Replicate II					
Close planting	7	0	0	28.6	42.8	28.6	—
Loose planting	9	0	22.2	44.5	11.1	22.2	—
Check	5	0	20.0	40.0	40.0	0	—
		Replicate III					
Close planting	16	0	0	50.0	43.75	6.25	—
Loose planting	17	0	0	53.0	29.40	17.60	—
Check	20	0	5.0	40.0	30.0	25.0	—
August 2		Replicate I					
Close planting	8	—	—	—	—	—	2
Loose planting	3	—	—	—	—	—	1
Check	17	—	—	—	—	—	4
		Replicate II					
Close planting	3	—	—	—	—	—	3
Loose planting	3	—	—	—	—	—	1
Check	0	—	—	—	—	—	0
		Replicate III					
Close planting	5	—	—	—	—	—	1
Loose planting	6	—	—	—	—	—	2
Check	6	—	—	—	—	—	1

TABLE 2. Number of plants and percentage of plants infested with Colorado potato beetle larvae, July 17

Treatment	No. of plants infested	Percentage of plants infested
	Replicate I	
Close planting	0	0
Loose planting	0	0
Check	0	0
	Replicate II	
Close planting	4	18
Loose planting	5	26
Check	7	33
	Replicate III	
Close planting	7	37
Loose planting	10	48
Check	9	42

Radish plants were thinned out twice so as not to overcrowd the cucumber plants. Plant vigor was extremely poor at all times.

On June 19, cucumber plants were counted and rated according to their vigor and amount of beetle damage evident. A grading system of one to five was used, with a score of one to be given to healthy, vigorous plants and five for a plant still alive but badly damaged. No plants escaped beetle injury, so none were assigned a grade of one.

A second count was made on August 2 of living plants and number of plants bearing fruit. The few cucumbers that were produced were all malformed and small in size. A final check was made on August 18, at which time the remaining plants were failing rapidly with cucurbit wilt disease. Results are given in Table 1.

2. *Snapbeans with Potatoes:* The seed pieces were dropped at approximately 12-inch spacings and covered with soil. The beans were planted at the designated points. Both the beans and potatoes grew well and were vigorous until Hurricane Agnes came June 21-23.

In mid-June, Colorado potato beetles were noticed in small numbers on all treatments. The hurricane greatly reduced the number of beetles. Infested plants were checked on July 17, but the number of larvae per plant were few and damage was minor.

Flea beetle damage was moderately low in all plots. Potato leafhoppers moved onto the plants in early July. The population of leafhoppers on July 7 and July

TABLE 3. Weight in pounds of potato tubers from 10 plants per treatment, September 6

	Close planting	Loose planting	Check
Replicate I			
	13 lb. 14 oz.	12 lb. 2 oz.	11 lb. 14 oz.
Replicate II			
	13 lb. 14 oz.	12 lb. 2 oz.	13 lb. 2 oz.
Replicate III			
	9 lb. 3 oz.	11 lb. 5 oz.	10 lb. 10 oz.
Average	13 lb. 5 oz.	11 lb. 7 oz.	11 lb. 9 oz.

TABLE 4. Grade assigned to ten heads of cabbage per plot when scored for imported cabbage worm damage.

Treatment	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Replicate I					
Close planting	0	0	0	1	9
Loose planting	0	0	0	1	9
Check	0	0	0	2	8
Replicate II					
Close planting	0	0	0	2	8
Loose planting	0	0	0	1	9
Check	0	0	0	2	8
Replicate III					
Close planting	0	0	0	0	10
Loose planting	0	0	0	1	9
Check	0	0	0	1	9

17 was three and five per sweep respectively. "Hopper burn" was very evident from late July until mid-August when the plants went down completely.

Weight records were taken on the tubers from plants 3, 5, 7, 9, 10, 11, 12, 14, 16 and 18 from each plot on September 6. Results are given in Table 2 and 3.

3. *Onions with Carrots:* There was no evaluation of this combination made due to the lack of insect pests. A net swept over the tops of plants three times during the summer revealed no leafhoppers on any of the plots, including the checks. Size and vigor of the carrot plants was rated equal for all treatments. Harvested roots showed no blemishes in any of the treatments.

4. *Marigolds with Snap Beans:* There was no evaluation of this combination made due to the lack of Mexican bean beetles. Observations made on June 16 showed a uniform infestation of one adult per three plants. However, the beetles disappeared from the plots during the rain and mud produced by Hurricane Agnes and none reappeared during the remainder of the summer.

The plants in all plots produced good quality beans with no apparent difference in yield between individual plants in each treatment.

5. *Thyme with Cabbage:* The only insect pest of any importance present throughout the growing season was the imported cabbage worm. On August 2, 10 consecutive plants per row were scored on a scale of one to five, with the latter being the most severely damaged. All plants were badly damaged and contaminated with fecal pellets. Plants assigned a grade of 4 required the removal of from nine to twelve wrapper leaves to discard all feeding damage, larvae, or fecal pellets from the cabbage heads. A grade of 5 was assigned all plants that required the stripping of more than 12 wrapper leaves to remove all larvae and damage. Infestations were such that no scores better than four were assigned.

Results are given in Table 4.

6. *Catnip with Eggplant:* Flea beetles moved onto the plants in moderate numbers in early June. Hurricane Agnes caused a sharp drop in numbers and the population remained fairly low until early August when moderate numbers were again noticed and these remained until frost.

No other insect problems developed on the eggplant and all plants produced a good crop of quality fruits.

Feeding incidence of flea beetles was measured for the first generation on June 16 and for the second generation on September 28 by counting the feeding punctures in 20 leaves from each treatment. Four shoots on each of five plants were selected at random from each treatment with the third leaf from the tip of each shoot being chosen for the count.

The results are given in Table 5.

Results

The companionate combinations used in our tests showed no measurable or visible indication of offering protection from insect damage. There was no difference in insect damage, plant vigor, or average yield per plant between treatments and the check plots.

The cucumber crop was a total loss due to direct feeding of striped cucumber beetle adults and larvae and to the bacterial disease of the plants carried by the beetles. Radish plants did not provide any degree of protection from striped cucumber beetle attack.

There was more variation of Colorado potato larval infestation between replicates than between treatments within the same replicate. The numbers of larvae were few and in this test snap beans did not keep Colorado potato beetles from the potato plants.

All cabbage plants were severely damaged by feeding of larvae of the imported cabbage worm. There was no difference between treatments in the amount of damage present. Thyme did not offer any degree of protection from imported cabbage worm feeding.

Catnip did not keep the potato flea beetle off of eggplant. There was greater variation between replicates and individual plants within a treatment than

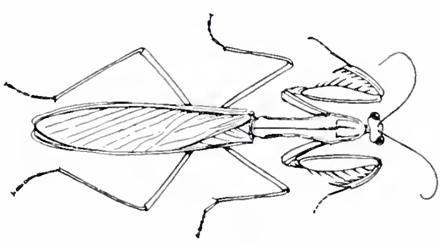
TABLE 5. Number of flea beetle feeding punctures per four leaves from five eggplants.

Close Planting		Loose Planting		Check	
June 16	Sept. 28	June 16	Sept. 28	June 16	Sept. 28
Replicate I					
288	256	380	300	204	184
499	387	418	340	482	340
346	246	496	280	334	360
396	265	174	176	578	280
392	398	482	360	176	280
1921	1552	1950	1456	1774	1444
Replicate II					
270	151	176	161	436	250
384	247	102	127	444	198
318	65	46	127	244	107
174	105	20	175	404	132
208	105	88	115	382	201
1354	673	432	705	1910	888
Replicate III					
274	448	58	305	170	188
84	356	58	290	86	280
96	156	112	360	152	350
120	353	122	230	136	336
134	270	264	260	184	270
708	1583	614	1445	728	1424
3983	**2908**	**2996**	**3606**	**4412**	**3756**

there was between the treatments. The same was true for both the early generation and late generation flea beetles.

Insect infestations did not materialize on the snap beans or carrot plots, so no evaluation of marigolds and onions as companionate plants could be made.

From the data collected from these tests, it appears that the companionate plants were of no value. The data also indicate that snap beans, carrots, and eggplant at least have the potential of producing a good crop without the need of any insect pest control. Cucumbers, cabbage, and potatoes are three vegetables that probably cannot be successfully grown without the aid of effective insect control methods.



Praying mantis

Organic gardening methods are especially feasible for the home gardener . . .

ORGANIC GARDENING—A DISCUSSION

L. H. MacDaniels

A DISCUSSION of organic gardening is particularly appropriate in this Handbook, NATURAL GARDENING. It is fitting also because many of the procedures and practices advocated by organic gardeners are feasible for the home gardener who is free from the necessity of meeting grading standards for vegetables and making a profit, both of which are conditions that dominate commercial ventures and large-scale food production. Thus the home gardener can accept or at least tolerate off-grade produce or crop failure that would be unacceptable commercially.

Organic gardening appeals to diverse groups of people. Some regard it almost as a religion with a philosophical background. Defined in terms of what organic gardeners recommend and practice, the concept includes the following:

- Growing food crops without the use of inorganic chemical fertilizers.
- Maintaining soil fertility by recycling all organic wastes through composting and by using mulches.
- Growing crops without the use of poison sprays or weed killers.
- Using "natural" foods free from preservatives, conditioners or other additives and promoting food grown the "organic" way.

There is truth in these concepts and procedures—up to a point. However, some of them are based on premises contrary to well established facts or are unrealistic for the large scale production which is necessary to feed the people on the earth. The following discussion aims to point out what is good and feasible in organic gardening and also its limitations.

Perhaps the most controversial claim for organic gardening is that organic fertilizers are somehow superior to those from an inorganic source and that the latter are responsible for a variety of human ills. (For an extensive discussion of this, see Dr. Johnson's article, page 37.)

By definition, an organic chemical is one that contains carbon which is combined with other elements in plant growth to make the plant structure. Of the sixteen elements essential for normal plant growth, all are derived from inorganic sources except possibly some forms of nitrogen.

Once combined in plant tissue, these essential elements can be absorbed again by the plants only when reduced to their basic inorganic state. Thus the organic-inorganic controversy becomes an inconsequential "quibble" because whatever the source, the element is reduced to its inorganic form before it is absorbed.

Home gardeners may maintain their "organic" position by using a variety of materials described elsewhere in this Handbook, but the amount of these materials is inadequate and also expensive for large scale commercial production. Some fertilizers, such as urea and Cyanamide, are organic in that they contain carbon, but because they are artificially synthesized are not acceped by some organic gardeners.

Excessive Use of Nitrogen

A serious and valid criticism of the use of concentrated synthetic fertilizers is that, in order to secure maximum yields, excessive amounts of nitrogen are sometimes used. This has occurred in the corn lands of the middle western United States where some wells and streams have nitrogen content above levels harmful to health. Also, care must be used in applying concentrated fertilizers to avoid injury to the plants.

Organic matter in the soil improves tilth by the aggregation of soil particles, increases the soil's water-holding capacity, releases nitrogen and other plant nutrients as it decays and improves the soil in many other ways. The farmer gains these benefits by returning crop residues directly to the soil by plowing, crop rotation and the use of cover crops. The home gardener does not usually have the tools or the space to do this and relies on composting organic material and on mulches. In the composting process organic roughage is broken down by the action of bacteria, fungi and other soil organisms. In the process the bulk of the material is greatly reduced and nutrients are lost as ammonia and by leaching. The benefit of composting is mainly the reduction of the roughage to a form that is not unsightly and can be easily handled. The compost pile is also a method of recycling organic matter which would otherwise not be available for use. Home gardeners can use a variety of materials—leaves, grass clippings, kitchen refuse, wood chips, plant trimmings, etc.

Mulching as Source of Organic Matter

An economical way to use organic matter in the garden is as a mulch. Using a mulch controls erosion, conserves water and nutrients, modifies soil temperature, lessens weed damage and promotes plant growth in other ways. Almost any organic material may be used, chosen according to its availability or cost and the importance of its appearance. Commonly used mulching materials are compost, leaves, lawn clippings, sawdust, wood chips, pine needles, shredded bark, ground corncobs, hay, straw and a host of others. Many of the beneficial effects of mulch can be secured by synthetic materials such as black plastic and aluminum foil but they cannot be worked into the soil to improve its structure.

If straw, sawdust, wood chips or other low nitrogen roughage is used, nitrogen fertilizer must be applied along with the mulch because the small amount of nitrogen in the mulch is used by the bacteria to decompose it, thus causing a nitrogen deficiency for the plants. Some disadvantages of mulching are that many of the materials are a fire hazard, that a thick mulch provides a place for rodents and that frost damage over a mulch may be greater than over bare ground. (A detailed account of mulches and their use can be found in the Brooklyn Botanic Garden HANDBOOK OF MULCHES. See back cover of this Handbook.)

Poisonous Sprays

Growing plants without the use of poison sprays is a major concern with organic gardeners. There is ample evidence and sound logic behind the position that hard pesticides such as DDT and dieldrin, neither of which are any longer available for use in the garden, are poisoning the environment Obviously, poisons used for insect and disease control should be biodegradable and used as sparingly as possible to achieve acceptable control and at the same time not destroy useful organisms. In a natural ecosystem all forms of life are adjusted to coexistence with each other. Unfortunately, everywhere man has gone this balance has been upset. New pests and diseases have been introduced against which "natural" controls are ineffective and some of the most desirable crops cannot be successfully grown without some chemical control.

To be sure, damage to vegetables can be lessened by picking tomato worms and potato bugs by hand or introducing lady bugs and praying mantises, destroying infested plant refuse, and following similar procedures. In the home garden, some vegetable plants in some seasons will escape pests and diseases and produce satisfactory or at least acceptable crops. On the other hand the crop from unsprayed apple trees or from potatoes without early and late blight control with a fungicide will be practically worthless.

The gardener should take advantage of the available varieties of vegetables which are resistant to insect and disease injury and encourage further research in breeding plants for this purpose. Another area of research is to achieve biological control of pests particularly in the forests where some damage is acceptable. Some organic gardeners will accept pyrethrum, rotenone and nicotine as pesticides because they are "organic." In my thinking, it is no more "natural" to kill an insect with these materials than with some other biodegradable poison. Further, the amount of the "natural" insecticides is wholly inadequate to meet the needs of commercial food production which has to meet the strict grading standards of the market.

Food Additives

In addition to growing vegetables organically, an important thrust of the organic gardening movement is to protest the use of additives in food sold in the markets. There are literally hundreds of these, some of which are detrimental to health as witnessed by the recent ban on several of them. The protest is also aimed at food processing that removes vitamins and other basic nutrients. Processing methods and the use of additives have been developed to make our present methods of food distribution possible and add to the shelf life of processed foods. Also some additives increase the vitamin and nutrient value of the product. It would be in order, however, to take a hard look at the present situation to determine what additives are really necessary.

To summarize, there is much that is good about organic gardening. In "gardening with nature" a person gains an appreciation of the earth and how things grow. In a small way it is possible to grow crops according to the methods advocated even though some of these are based on half truths and in some cases are contrary to established scientific facts. By ignoring such facts and failing to recognize the limitations of the organic gardening methods in large scale food production, the whole organic gardening position is weakened.

The above is a very incomplete statement. Additional information and greater detail can be secured from bulletins and basic texts in agronomy and plant physio'ogy. Reference should also be made to various extension bulletins, including Cornell University Information Bulletin No. 36 "Facts About Organic Gardening" (15 cents), and Bulletin No. 39, "How to Grow Vegetables Organically" (20 cents). Both may be obtained by mail from Mailing Room, Building 7, Research Park, Cornell University, Ithaca, New York 14850.

A demonstration of trickle irrigation. Dew hose has been placed along a row of gladiolus. Darkened area shows continuous pattern of wetting from the hose.

A. L. Kenworthy

A system that saves water yet waters plants more efficiently

RELAX WITH TRICKLE IRRIGATION

Harry G. Ponder

From Plants and Gardens, Vol. 29, No. 4

If a productive home garden or a healthy green landscape is your desire and frequent moving of sprinklers is not your idea of fun, trickle irrigation may be for you. This watering technique was developed in England in the late 1940's for greenhouse tomatoes. More recently it has been put to work in orchards and nurseries of arid regions. Due to a lack of publicity its potential application for homeowners has not been appreciated. Based on my research which trickle irrigation in nurseries and home gardens, I believe that trickle irrigation may fulfill an important need around the home.

Why Use Trickle Irrigation?

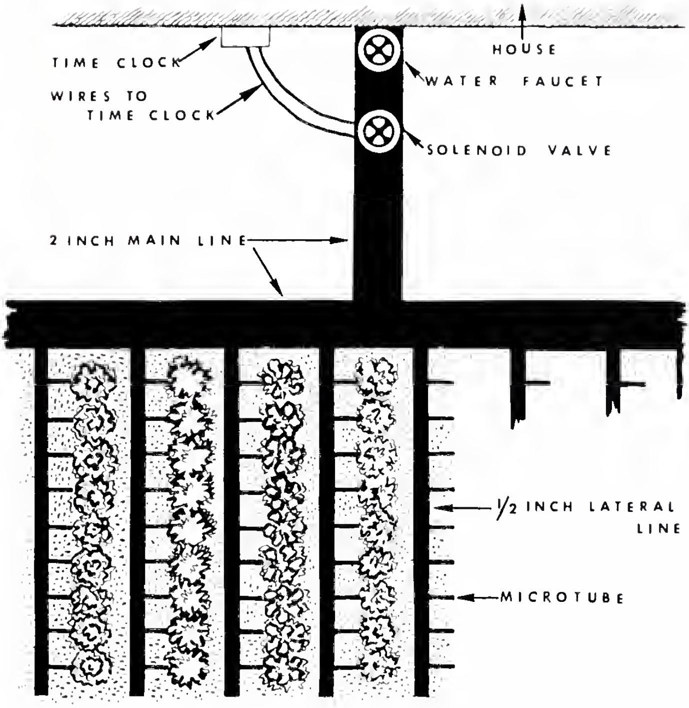
In nearly every part of our country some form of watering is needed to supplement natural rainfall sometime during the growing season. Without it plants suffer from drought. With trickle irrigation water is applied daily. Optimum moisture conditions are maintained continuously for each plant. The results are better growth, better flowering and better yields. Trickle irrigation acts as an insurance policy against droughts. The water is applied directly to the area in which the plants' roots are located and not to the area between rows. This discourages weed growth between rows, and conserves water.

With a completely automated trickle system, a substantial amount of time and labor is saved in the actual watering process. Vacation periods can be enjoyed without worrying about the garden and landscape plants suffering from lack of water. And lastly, this system is inexpensive and can be installed by the average homeowner, from materials that may be obtained locally from a good plumbing supply store.*

What Is Trickle Irrigation?

Trickle irrigation is the daily maintenance of an adequate section of the root zone with enough moisture to prevent water stress. A trickle system consists of a

* If unable to obtain materials locally, send a stamped, self-addressed envelope to the Editor for a list of suppliers. Also, consult classified pages of your local telephone directory under "Greenhouse Equipment," where much of the material can usually be obtained.



Eva Melady

DIAGRAM OF TRICKLE IRRIGATION

Right: Punch, grommets and the installed microtube used in trickle irrigation method.

series of black plastic pipes (½ inch diameter is sufficient for most home gardens) set down along the plant rows so that a pipe lies near the plants. All of these pipes are connected by a single main line from a water source. Periodically an emitter (water outlet) is placed in the pipe to emit water at a predetermined rate to a specific location. A gate valve in the main line can be used to control the system's pressure, or a solenoid valve and a time clock can be used to completely automate the system. Thee system is also amenable to fertilizer injection.

Home Installation

Trickle irrigation operates at low pressure. Since it requires less total water when compared to other irrigation systems, it can be adapted easily to the home water system. A female garden hose adapter, inserted on the end of a ½-inch black plastic pipe, allows the pipe to be attached to an outside faucet. This ½-inch main line, which is usually buried to eliminate traffic problems, such as lawn mowers and other equipment, runs from the water source to the garden area. It can be run along one side of the garden or, depending on the garden's orientation and size, can be run through the middle of the garden. Upright pipes with connectors are inserted in the main line at all points where a lateral line extends down a planted row. Black plastic pipe (½ inch) can be used for the lateral with emitters spaced at every plant or every other plant.

Microtubes are the cheapest emitters available, and they are quite reliable. They are very small inside-diameter plastic pipes: .025-inch, .035-inch, and .045-inch inside diameter. To install them a small-size calibrated punch, similar to an ice pick, is used to puncture the lateral and insert a grommet. The microtube is inserted in the grommet and is held there by friction fit. The inside diameter and length of the microtube determine how

A flow control valve (*center*) that has been installed in a piece of ½-inch black plastic pipe. A gate valve is shown above the plastic pipe.

Arrow points to area where microtube extends from the lateral line. Darkened soil area shows wetting pattern between the two pepper plants.

much water is put on a plant per hour. Usually one to 2 gallons per hour is a desirable flow rate. How long the system should operate per day depends principally on the soil type. Other types of emitters, besides microtubes, are available, but they are more expensive.

Dew hose is an alternative lateral to the black plastic pipe emitter system described above. Dew house is a pliable plastic pipe which is sewn together with nylon thread forming a seam on one side. Water is emitted along this seam and a continual wetted pattern is formed down the row as contrasted to the intermittent wetted patterns formed when individual emitters are used. Four to 8 pounds pressure is all that is needed for the hose to operate. For home gardens, the dew hose is very promising.

With an inexpensive time clock connected to a ⅜-inch solenoid valve placed in the main line, the whole system can be automated a few hours daily.

The above principles and general design—with a few modifications—can also be used to make a watering system for the foundation plants around the house.

Based on our experience, we enthusiastically endose trickle irrigation as a tool that the home gardener can use to make his gardening easier and more rewarding.

References

Kenworthy, A. L. 1972. *Trickle Irrigation: the Concept and Guidelines for Use.* Research Report 165 from the Michigan State University Agricultural Experiment Station, East Lansing. 19 pp.

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Are they more nutritious?

ORGANIC FOODS

Evelyn H. Johnson

THE term "organic" describes all living things. "Organically grown" foods are ones raised without the use of agricultural chemical fertilizers and pesticides. Soil deficiencies are corrected by the use of decaying animal manure and green compost and so-called non-organic fertilizers such as limestone and rock phosphate.

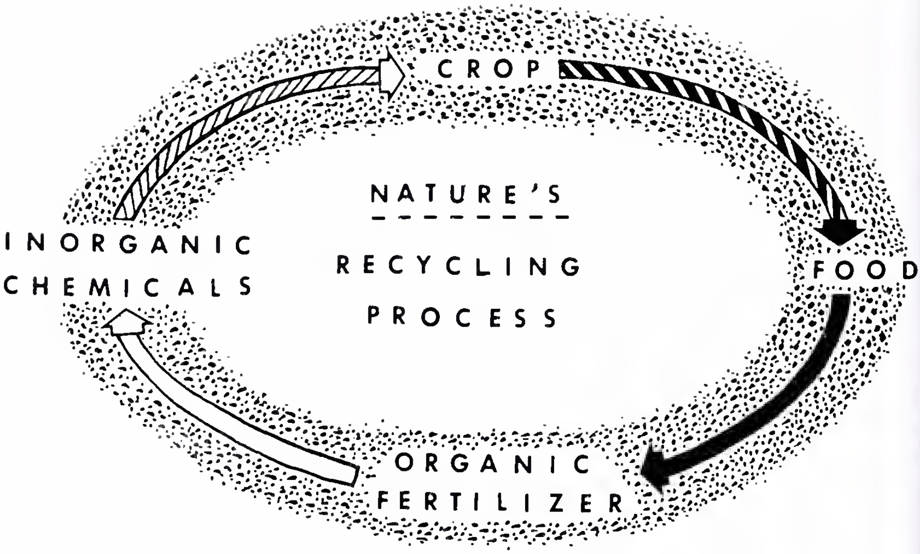
There have been many changes in agricultural practices in the past 30 years. They have had relatively small effect on the average nutrient composition of our food and feed crops, but claims are often made that organically grown foods are nutritionally superior to foods grown under standard agricultural conditions using chemical fertilizers. Can these claims be justified?

Many things influence the nutrient content of a plant. Among them are climate, the amount of sunlight, and the stage of maturity when the plant is harvested, together with the kind of nutrient material available to the plant for growth.

To understand nutrient content better we need to know that plants take simple substances—water, minerals, nitrogen, and energy from the sunlight—for their own growth. In so doing, they synthesize carbohydrates, fats, proteins, and vitamins according to their own plant individuality. To exist at all, plants must be able to take essential minerals from the soil. A tomato or potato is complete, or it simply isn't there. The plant will make and store in its leaves, stem, fruit, and seeds the nutrients which that plant's heredity dictates.

The inherited genes in a carrot cause it to develop a relatively large amount of vitamin A value, just as the genes in

Molly Adams
All home vegetable gardeners agree that the home-grown produce is superior to the store product in freshness and flavor.



Eva Melady

an orange are responsible for its high vitamin C content. Through breeding, strains of corn with a higher protein (lysine) content have been developed. Apples can be bred to have more ascorbic acid (vitamin C) but the ascorbic acid of the apple and the protein of the corn will not be altered by a change in fertilizer.

Results of Research

Scientists at the United States Plant, Soil and Nutritional Laboratory in Ithaca, New York compared organic fertilizers to agricultural chemical fertilizers concerning their effect on certain nutritive constituents of plant crops. The following conclusions emerge from their study:

The vitamin A value and ascorbic acid content of snap beans and carrots was about the same whether the soils were fertilized with organic or chemical fertilizers.

The vitamin A value content of carrots was higher when relatively large quantities of chemical fertilizer were used as compared to moderate quantities, or to organic fertilizers. The difference was attributed to the larger size of the carrots.

The vitamin C and vitamin A value of seedling rye grown on plots receiving large quantities of manure over a 25-year period were the same as in rye from plots fertilized with chemical fertilizers for the same period.

The vitamin C, iron, and copper content of potatoes remained the same whether the soil was manured for 25 years or was treated with chemical fertilizers over the same period.

In 1972 marketeers of whole grain flour published results of chemical analyses of wheat from seven "organic" farms. When compared with average figures in the *USDA Handbook on Composition of Foods* for nutritional content, little difference can be noted.

Nutrient material must be in the inorganic (chemical) form to be absorbed by the plant. This means that manure and compost must be broken down by bacteria into chemicals before they can be absorbed by the plant's root system. Therefore, the so-called organically produced food is actually inorganically grown. When a plant takes up a mineral from the soil, it makes no difference whether that mineral was derived from chemical fertilizers or released from plant or animal materials.

While there are lands where soils low in vitamin A precursor, for example, can be enriched to produce higher yields by the addition of animal manures, several tons per acre may be needed. There are phosphorus-poor soils in other sections that can be brought up to par by adding chemical phosphorus fertilizer.

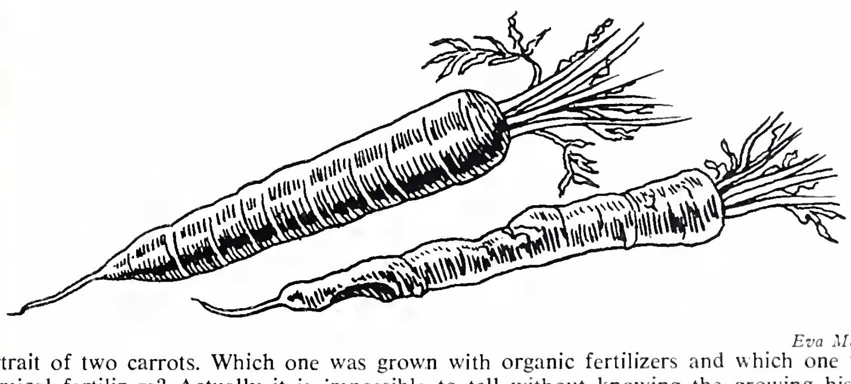
Before planting, soils should be analyzed. (See page 56.) Test results give indications for selection of kinds and amounts of fertilizer. However, no amount of fertilizer, either organic or chemical in nature, will add vitamins and minerals to a plant beyond the level given that plant by its genetic nature. But what if plant minerals are in the ground, but sparse? In that case, there will be fewer plants. The yield rather than the nutritional quality of the plant will be affected.

Gardeners considering the use of organic fertilizers should be alert to their unique qualities in improving soil structure. Organic fertilizers increase aeration and the development of soil organisms, improving tillage and water absorption and retention. On the other hand, they only replenish the supply of nutrients that were used by plants previously planted in the soil. Furthermore, organic fertilizers are one of the greatest sources of salmonella, an organism that causes a common form of food poisoning.

There is also a limit to the amount of organic foods that can be grown feasibly. It is one thing to grow a few rows of tomatoes in the home garden using organic fertilizer, but quite another thing to grow enough food for a large family, much less a nation, by such methods. This factor is reflected in the high price of organic foods in the markets, which now cost at least one-third more to twice as much as the same foods in the regular food stores. It is a high price to pay for food that may or may not be fresher and more flavorful but is no more nutritious than foods grown with agricultural chemical fertilizers. But the price picture may change in the future. Increased use of organically grown foods may come about because of economic pressures, especially if the cost of energy used in manufacturing fertilizer increases faster than food prices. Also, our growing commitment to reduce waste and to recycle as much organic material as possible may lead to more home gardening in this manner.

Possible Deception

Because the Food and Drug Administration, as yet, has no control over the marketing of organically grown foods, the public might be deceived in some instances by mislabeling. Foods grown in most areas of the country require some type of chemical fertilizer and pest control. Therefore, not all foods labeled organically grown are actually that. The public is paying considerably higher prices for foods labeled "organic foods." Often, these foods are of inferior quality



Eva Melady

Portrait of two carrots. Which one was grown with organic fertilizers and which one with chemical fertilizers? Actually it is impossible to tell without knowing the growing history of each carrot: kind of soil, nutrients available (from either organic or chemical sources) and availability of moisture.

in that they are smaller and more fibrous.

Preserving the nutritive value of fresh fruits and vegetables from the garden to the table requires great care and forethought. Maintaining freshness is the key to maintaining nutritive value. But maintaining freshness, including the desirable flavor which it connotes, has nothing to do with the way foods are fertilized. Freshness depends on the manner and the time of harvesting, handling, storage and preparation in the home.

It should be remembered that the nutritional well-being of a family depends not only on the specific nutritional value of individual foods but also on the availability of a sufficient quantity and variety of foods that provide all essential nutrients. For information on the nutritive practices, contact your State Extension Nutrition Specialist at your state land grant university. Remember, there is no proven, substantial basis for claiming that plants grown with only organic fertilizer have a greater nutrient content that those grown by conventional methods.

Further Reading

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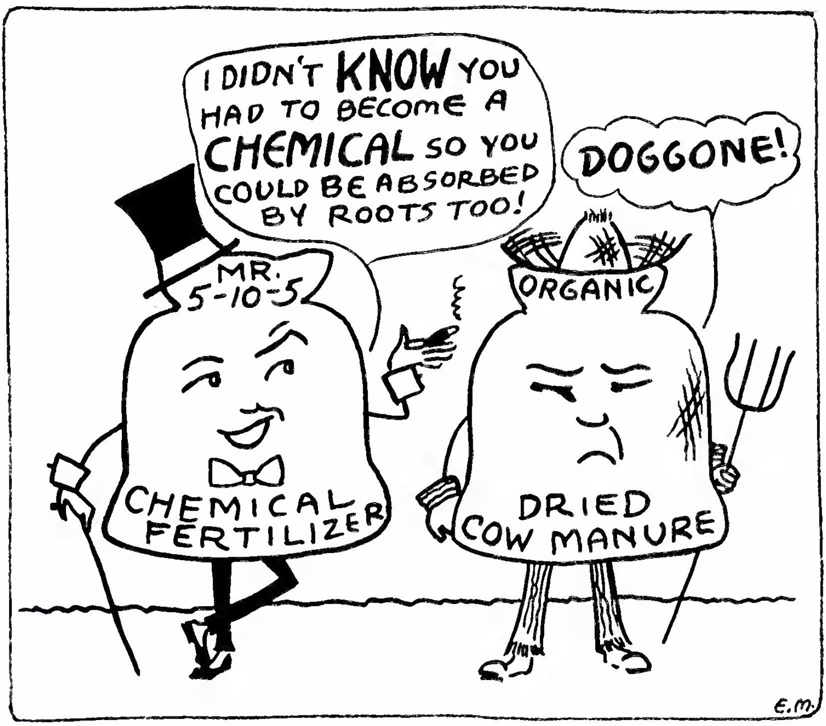

Sensible suggestions for southern gardeners and gardeners everywhere

ORGANIC MATERIALS IN WARM HUMID AREAS

D. O. Ezell and E. V. Jones

THE combination of warm soil temperatures and humid conditions found in the southern United States is not conducive to the retention of organic matter in the soil. It is not uncommon to find soils in humid regions with less than ½ percent organic matter. Many of these soils are sandy and lack beneficial quantities of clay as well. This lack of clay makes addition of organic material more important since clay particles perform some functions similar to organic matter.

Soils which are deficient in organic matter provide many handicaps to the gardener in any part of the country. Incorporation of such material serves many functions. It facilitates soil workability and provides better water and nutrient retention. It also improves the soil's "buffering" capacity (e.g., prevents drastic changes in acidity and availability of nutrients). Organic matter also supports soil micro-organisms, adds nutrition and releases nutrients slowly, while contributing substances which aid in the decomposition of rather insoluble materials.

In simple terms, when organic matter is applied to soils in warm climates, it is "burned up" and does not remain in soils indefinitely. This oxidation makes it necessary for the gardener to continually apply composted materials to keep the soil in good condition for successful organic gardening. For best results the planting bed should consist of 4 percent or more of compost.

That Compost Pile

The compost pile is the center of any organic maintenance program. While mulch materials provide valuable organic matter in the garden area, large quantities of undecomposed materials in the soil are not desirable. They are trashy-looking, difficult in which to sow seed, attract insects, harbor certain disease organisms and compete for nitrogen. When organic materials are incorporated into the compost heap, the decomposition process takes place within the pile, resulting in rich humus for application to the garden site.

There are various ways to build a compost pile. Here's one we have found satisfactory. Develop it by adding alternate layers of organic materials, soil, lime, and organic fertilizer. We suggest a one-foot layer of organic material. Spread a one-inch layer of soil over the organic material to make sure decay organisms are present. For each 100 square feet, add 5 pounds ground rock phosphate (preferred by organic gardeners to superphosphate) and one pound finely ground dolomitic limestone. Repeat the process until the pile is about 5 feet high. Depress the center slightly so that rain water will be directed into the compost heap.

After three or four weeks mix the parts thoroughly. In warm humid areas the compost should be ready for use in about six months. An indication of its readiness is the point where organic materials such as leaves are no longer distinguishable.

Many new gardeners, regardless of where they live, are uncertain of materials that can be placed in the compost pile. Generally speaking, any material that will rot can be composted. Many of these materials should be shredded or chipped into small pieces to hasten decomposition. Kitchen scraps are very satisfactory from a nutritive standpoint, but they often attract rodents before break-

Shredding wood chips, newspapers, leaves and other plant residue before adding them to the compost pile or soil greatly increases the speed of decomposition.

ing down (which may or may not be a problem in all areas). General applications of the composted organic matter should be at the rate of 25 pounds per 100 square feet, although much heavier applications would not be undesirable.

Useful Organic Materials

Here are some of the organic materials satisfactory in our part of the country:

Leaves, grass clippings, and shrubbery prunings: Few cities or suburban areas now allow burning of leaves; many communities offer an autumn leaf pick-up service to their residents. Spread the word in the immediate neighborhood indicating your willingness to dispose of "other people's problems." Also, a call to the local sanitation department may help you find public leaf-dumping areas. Save all these items around the home; they accumulate rapidly.

Wood chips and sawdust: Large wood chips are converted to humus, but only very slowly. The speed of decomposition is increased when these chips are ground or shredded. Large wood chips are usually obtained free from companies which prune trees, clean power lines or contract for general tree removal. Wood shavings (sawdust) are available from wood-processing facilities including sawmills, some furniture manufacturers and even local cabinet shops. The fine wood shavings from a planer, edger or fine tooth saw are especially useful in compost piles.

Paper: While sources of shredded paper are difficult to obtain, it makes a desirable compost. Its primary use is as a packaging material for shipped goods. Local plants, stores or manufacturers may receive items packed in this way. A mechanical shredder would be necessary otherwise.

Newsprint and kraft-type paper is the most available source to the homeowner. Ink from newsprint is not considered harmful in the soil. Avoid the addition of wax and plastic-coated paper or the use of large amounts of dyed papers. Highly finished papers may also be degraded quite slowly.

Molded hay: Hay which has become wet and moldy is of little use to a farmer for animal food. This hay not only makes good filler for the compost heap but excellent mulch for all garden vegetables, especially strawberries. A leisurely drive into the country may turn up such supplies of "bad" hay. Advertising in local farmer bulletins is often rewarding.

Processing waste: Most pollution control authorities require that liquid food processing waste be contained by lagoon or treatment facility and is seldom avai able. Certain dry waste is available. Southerners may find these materials quite available.

Cotton motes are small waste particles expelled from cotton gins and textile plants. They are usually to be had for the asking, but it should be noted that considerable weed seeds will accumulate in this waste.

Peanut-processing plants have large quantities of hulls as a waste product. They may be free or available at a small charge.

Cane bagasse—While the organic by-product from large sugar-processing plants (cane bagasse) is usually burned for extra fuel, small syrup and molasses mills throw away large amounts of waste cane fiber. Certainly other processing facilities exist which have degradable cellulose as a commercially useless by-product.

Animal litter and manures: Prime locations for such wastes are show grounds, race tracks, riding clubs and commercial enterprises. Ranches may be a less likely source, as they may be equipped to mechanically dispose of such waste or use the waste as fertilizing material on their farms. For such a valuable product, some effort can be rewarding.

Fertilizing the garden with other organic materials can be accomplished without composting. Usually these materials are high in one or more of the three major elements needed for plant growth (nitrogen, phosphorus and potassium). The following table presents many of these useful materials, indicating their nutritive value.

Commercially mixed organic fertilizers containing balanced quantities of plant food are marketed in most areas. They are usually formulated by mixing several of the listed materials to obtain the desired balance.

Soil testing can be just as beneficial to the organic gardener as to the conventional gardener. (See page 56.)

A Course of Action

Using the table above, the gardener can select available fertilizing materials that will provide a balance of plant nutrients. For example, having applied 25 pounds of compost per 100 square feet, the gardener may then choose to add for

The nitrogen cycle

NITROGEN from plant and animal protein is useful to plants only after a complicated conversion process. The process is many times referred to as the nitrogen cycle. Different types of soil micro-organisms, bacteria and fungi are responsible for this change.

STEP 1: In the process of decay, the complex proteins are broken down into a number of simpler compounds. Most of the nitrogen within plant and animal residue is released as ammonia. The ammonifying organisms must be present before the change will occur. There are large quantities of these organisms in the soil.

STEP 2: Plants cannot use large quantities of ammonia. This ammonia must be converted to nitrate nitrogen before it is useful to them. Different micro-organisms are responsible for this change.

It is possible for this process to work in reverse in the presence of denitrifying bacteria. For this reason, it is desirable to compost carbohydrate materials before incorporating into the soil.

STEP 3: Plants may now use the nitrogen which was originally assembled as undecomposed organic matter.

STEP 4: Most of the earth's atmosphere is nitrogen. But this nitrogen is in a form that most plants cannot use. Through various processes, a small amount reaches the soil and is converted to useful nitrogen. Legume crops such as soybeans have the capability to fix and accumulate atmospheric nitrogen. After these crops are harvested, the nitrogen they assimilate can be used by other plants. When combined, these individual processes are commonly called the nitrogen cycle; a cycle basic to life itself.

Average Nutritive Content of Natural Fertilizers, Their Rate of Availability and Their pH Reaction

Organic Material	(Nitrogen) %N	(Phosphorus) % P_2O_5	(Potassium) % K_2O	Availability	pH Reaction
General Sources					
Animal Manure	1.0	1.0	1.0	moderately	acid
Sewage Sludge	3.0	2.0	0.3	slowly	acid
Garbage Tankage	2.5	1.5	1.5	very slowly	alkaline
Cocoa Shell Meal	2.5	1.0	2.5	slowly	neutral
Cotton Seed Meal	6.0	2.5	1.5	slowly	acid
Soybean Meal	6.0	1.2	1.5	slowly	acid
Castor Pomace	5.0	1.8	1.1	slowly	acid
Peat and Muck	2.0	0.3	0.7	very slowly	acid
Bat Guano	10.0	4.0	2.0	moderately	acid
Peru Guano	13.0	8.0	2.0	moderately	acid
Nitrogen & Phosphorus Sources					
Fish Scraps	5.0	3.0	0.0	slowly	acid
Fish Meal	10.0	4.0	0.0	slowly	acid
Blood Meal	12.0	1.5	0.8	slowly	acid
Animal Tankage	6.0	3.0	0.1	slowly	acid
Horn & Hoof Meal	12.0	2.0	0.0	slowly	neutral
Milorganite	6.0	2.5	0.0	moderately	acid
Phosphorus Sources					
Bone Meal	3.5	22.0	0.0	slowly	alkaline
Ground Rock Phosphate	0.0	33.0	0.0	very slowly	alkaline
Basic Slag	0.0	8.0	0.0	quickly	alkaline
Colloidal Clay	0.0	2.0	0.0	moderately	neutral
Potassium Sources					
Green Sand	0.0	1.0	6.0	very slowly	neutral
Wood ashes	0.0	2.0	4.0* 10.0**	quickly	very alkaline
Seaweed	1.0	0.0	5.0	slowly	acid
Tobacco Stems	1.5	0.5	5.0	slowly	alkaline

* Softwood
** Hardwood

each 100 square feet:

25 pounds of animal manure
2 pounds of animal tankage
2 pounds of wood ashes
5 pounds of bone meal

This would be equivalent to the addition of 8 pounds of a 6-12-6 fertilizer, a rate too high for conventional fertilizers because they are rapidly available.

If a gardener has tested the soil and is aware of a deficiency, he may increase or decrease quantities of added fertilizer materials accordingly. For example, a garden soil may test very high in phosphorus and low in potassium. The gardener would continue to make the basi application of compost. In addition h would add for each 100 square feet:

25 pounds animal manure
8 pounds wood ashes
3 pounds blood meal

Note: Since wood ashes are quickl available and very alkaline, substitut another source if the pH is above 6. For soils testing low in phosphorus an very high in potassium, one might add per each 100 square feet: 5 pounds rocl phosphate (or 7 pounds bone meal) an 3 pounds blood meal.

IN THE CITY

MANY of the natural fertilizers and mulches mentioned in this Handbook are unavailable in cities, but this should in no way deter the urban gardener, who is almost by definition an innovative soul. The general principles covered in these pages apply to the city as well as to rural and suburban areas but there are a few differences that should be noted. Most city soils have been neglected over the years. They are often heavily compacted and, in some parts of the country, strongly acid. They are also short on organic matter and long on building rubble and other debris.

It may take several years to get a city soil into good tilth but it can be done without long trips into the country in search of rock phosphate, tankage and other materials esteemed by "organic" gardeners. A soil test can be useful as a first step, but in any case it will likely be advisable to incorporate healthy amounts of peat moss in the soil, also coarse builder's sand if the soil is heavy clay. Dolomitic limestone, readily available in urban garden centers, is the material most widely used by gardeners to make the soil less acid.

City soils are frequently deficient in phosphorous, an element that promotes root growth and flowering. Superphosphate, which differs from rock phosphate in that it has been treated with sulfuric acid, is a standard corrective, or the gardener can employ bone meal or a balanced synthetic fertilizer high in phosphorous such as 5-10-5. Gardeners in any city should be able to find one or more of these materials without too much difficulty. Phosphorous is not very mobile in the soil so it should be dug in rather deeply before planting time.

Compost piles are a problem in urban areas but one can adapt the trash bag method (see page 70). Probably the main point of concern in urban composting is rats, so be careful not to add decaying meat that will lure them. Coffee grounds (usually about 2 percent nitrogen) and similar materials from the kitchen are all right as soil builders over a long period but don't expect miracles. Their most important feature is in improving soil structure, not in adding nutrients.

City soils are often poorly drained. Installation of drainage tiles can be costly and bothersome, but many urban gardeners get around the problem by growing plants in raised beds or in containers. In fact, by raising plants in containers, the city gardener can have a much greater precision in regulating growth than if they are grown in the open field.

As always, a summer mulch is eminently useful. Peat moss, the most commonly available material in urban garden centers, is not really a good mulch because it cakes when dried out and prevents water from seeping through to the soil. If you have to settle for it instead of cocoa bean shells, buckwheat hulls or other porous mulch, make sure to keep it moist at all times. Peat with its crumbly black texture is a passable mulch and is sometimes used in place of peat moss. Black plastic, an "inorganic" mulch, is increasingly used in city gardens. To make it more attractive, a thin layer of pine bark or wood chips can be spread over the top.

Insecticides are occasionally needed in a city garden but there can be less reliance on them than in the country. With smaller garden size and fewer plants grown, it is no real chore to give plants individual attention and to hand pick many of the common insect pests. One of the blessings of a small garden is that the severe infestations that sometimes occur when acres and acres of a particular vegetable are grown don't appear. This is not to say that you won't have pests, but it helps considerably to grow

George Taloumis
Wood chips make an attractive yet practical mulch for a planting on a narrow city lot.

just a few plants of a particular kind and to vary them from year to year.

Plants for city gardens have to be selected with greater care than for country ones. Shaded sites are more the rule than the exception, but there are many excellent ornamentals—and a few vegetables—which will grow well in filtered light. Among the standard bedding plants are impatiens, wax begonia and coleus.

Tomatoes, squash and other vegetables that are dependent on good light to form flowers and develop fruit will sometimes disappoint the city gardener, but leaf crops (e.g., lettuce, spinach, chard, mustard, parsley, etc.) generally perform well, as do ones grown for their edible roots (radish, carrots, beets, etc.). A good practice with city plants, especially the leafy vegetables, is to gently syringe or wash the foliage with a hose from time to time so that dust doesn't accumulate. Frequent light applications of a water-soluble fertilizer high in nitrogen, which encourages leafy growth, can help you grow excellent greens and even such salad vegetables as tomatoes.

Varietal selection becomes more important in city gardens, where space is limited. In recent years a number of miniature vegetables have been bred for the small piece of land. Among them are 'Tiny Tim' and other patio-type tomatoes, 'Tom Thumb' lettuce and 'Cherokee' cucumber. (For more details, see J. M. Lent's article on mini-vegetables in the B.B.G. Handbook on THE HOME VEGETABLE GARDEN. In the same Handbook there is also an article on ornamental vegetables, which have a particular role in city gardens where plants may have to serve a double duty. See back cover of this issue for ordering information on THE HOME VEGETABLE GARDEN.

Perhaps a word or two should be directed to the indoor gardener who wants to put to work some of the ideas mentioned in this Handbook. Good light becomes even more important than in the outdoor city garden and so does moisture, because modern apartments are sometimes almost like desert environments in their aridity. However, one can have almost complete control of the soil by proper mixes. (See the B.B.G. Handbooks on house plant subjects.) The same is true with fertilizers. Water-soluble sorts (Miracle-gro, Rapid-gro), while not accepted by all "organic" gardeners, are remarkably clean and easy to use—and to store. Processed fish emulsion fertilizer is also widely employed by indoor growers but don't use it just before company comes!

Montague Free, who served as Horticulturist at the Brooklyn Botanic Garden for three decades, always recommended the Saturday morning bath for house plants. It's still a valid prescription in cutting down on insects. One must also be a bit ruthless and discard badly infested house plants. If you follow these practices, it may never be necessary for you to use an insecticide in the apartment. However, it is good to know that there are a number of "all-purpose" house plant insecticides stocked by urban garden centers in case you really need them. In all cases follow spray recommendations carefully.

Nature can set the planting dates

PLANTING THE GARDEN BY THE WEATHER

ONE of the most important elements of success in growing vegetables is planting, or transplanting, each crop at the time or times that are best for the operation in each locality. Temperatures often differ so much between localities not many miles apart that the best planting dates for some one vegetable may differ by several days or even 2 weeks.

Vegetable crops may be roughly grouped and sown according to their hardiness and their temperature requirements. The frost-free date in spring is usually two to three weeks later than the average date of the last freeze in a locality and is approximately the date that oak trees leaf out.

The gardener naturally wants to make the first planting of each vegetable as early as he can without too much danger of its being damaged by cold. Many vegetables are so hardy to cold that they can be planted a month or more before the average date of the last freeze, or about six weeks before the frost-free date. Furthermore, most, if not all, cold-tolerant crops actually thrive better in cool weather than in hot weather and should not be planted late in the spring in the southern two-thirds of the country where summers are hot. Thus, the gardener must time his planting not only to escape cold but with certain crops also to escape heat. Some vegetables that will not thrive when planted in late spring in areas having rather hot summers may be sown in late summer, however, so that will make most of their growth in cooler weather.

A gardener anywhere in the United States can determine his own safe planting dates for different crops by using the maps (figs. 12 and 13), together with tables 4 and 5. The maps show the average dates of the last killing frosts in spring and the average dates of the first killing frosts in spring and the average dates of the first killing frosts in fall. They are the dates from which planting times can be determined, and such determinations have been so worked out in tables 4 and 5 that any gardener can use them, with only a little trouble, to find out the planting dates for his locality.

Table 4, for use with the map in figure 12, shows planting dates between January 1 and June 30, covering chiefly spring and early-summer crops. It shows *how early it is safe to plant;* it also shows the spring and early-summer dates *beyond which planting usually gives poor results.*

Opposite each vegetable in table 4, the first date in any column is the *earliest generally safe* date that the crop can be sown or transplanted by the gardener using that column. (No gardener needs to use more than one of the columns.) The second date is the latest date that is likely to prove satisfactory for the planting. All times in between these two dates may not, however, give equally good results. Most of the crops listed do better when planted not too far from the earlier date shown.

To determine the best time to plant any vegetable in the spring in your locality:

1. Find your location on the map in figure 12 and then, the solid line on the map that comes nearest to it.

2. Find the date shown on the solid line. This is the average date of the last killing frost. The first number represents the month; the second number, the day. Thus, 3—10 is March 10. Once you know the date you are through with the map.

3. Turn to table 4; find the column

(*Text continued on page* 51)

TABLE 4.—*Earliest dates, and range of dates, for safe spring planting of vegetables in the open*

Crop	Planting dates for localities in which average date of last freeze is—						
	Jan. 30	Feb. 8	Feb. 18	Feb. 28	Mar. 10	Mar. 20	Mar. 30
Asparagus [1]					Jan. 1–Mar. 1	Feb. 1–Mar. 10	Feb. 15–Mar. 20.
Beans, lima	Feb. 1–Apr. 15	Feb. 10–May 1	Mar. 1–May 1	Mar. 15–June 1	Mar. 20–June 1	Apr. 1–June 15	Apr. 15–June 20.
Beans, snap	Feb. 1–Apr. 1	Feb. 1–May 1	Mar. 1–May 1	Mar. 10–May 15	Mar. 15–May 15	Mar. 15–May 25	Apr. 1–June 1.
Beet	Jan. 1–Mar. 15	Jan. 10–Mar. 15	Jan. 20–Apr. 1	Feb. 1–Apr. 15	Feb. 15–June 1	Feb. 15–May 15	Mar. 1–June 1.
Broccoli, sprouting [1]	Jan. 1–30	Jan. 1–30	Jan. 15–Feb. 15	Feb. 1–Mar. 1	Feb. 15–Mar. 15	Feb. 15–Mar. 15	Mar. 1–20.
Brussels sprouts [1]	Jan. 1–30	Jan. 1–30	Jan. 15–Feb. 15	Feb. 1–Mar. 1	Feb. 15–Mar. 15	Feb. 15–Mar. 15	Mar. 1–20.
Cabbage [1]	Jan. 1–15	Jan. 1–Feb. 10	Jan. 1–Feb. 25	Jan. 15–Feb. 25	Jan. 25–Mar. 1	Feb. 1–Mar. 1	Feb. 15–Mar. 10.
Cabbage, Chinese	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Carrot	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Jan. 15–Mar. 1	Feb. 1–Mar. 1	Feb. 10–Mar. 15	Feb. 15–Mar. 20	Mar. 1–Apr. 10.
Cauliflower [1]	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 10–Feb. 10	Jan. 20–Feb. 20	Feb. 1–Mar. 1	Feb. 10–Mar. 10	Feb. 20–Mar. 20.
Celery and celeriac	Jan. 1–Feb. 1	Jan. 10–Feb. 10	Jan. 20–Feb. 20	Feb. 1–Mar. 1	Feb. 20–Mar. 20	Mar. 1–Apr. 1	Mar. 15–Apr. 15.
Chard	Jan. 1–Apr. 1	Jan. 10–Apr. 1	Jan. 20–Apr. 15	Feb. 1–May 1	Feb. 15–May 15	Feb. 20–May 15	Mar. 1–May 25.
Chervil and chives	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 15–Feb. 15	Feb. 1–Mar. 1	Feb. 10–Mar. 10	Feb. 15–Mar. 15.
Chicory, witloof					June 1–July 1	June 1–July 1	June 1–July 1.
Collards [1]	Jan. 1–Feb. 15	Jan. 1–Feb. 15	Jan. 1–Mar. 15	Jan. 15–Mar. 15	Feb. 1–Apr. 1	Feb. 15–May 1	Mar. 1–June 1.
Cornsalad	Jan. 1–Feb. 15	Jan. 1–Feb. 15	Jan. 1–Mar. 15	Jan. 1–Mar. 1	Jan. 1–Mar. 15	Jan. 1–Mar. 15	Jan. 15–Mar. 15.
Corn, sweet	Feb. 1–Mar. 15	Feb. 10–Apr. 1	Feb. 20–Apr. 15	Mar. 1–Apr. 15	Mar. 10–Apr. 15	Mar. 15–May 1	Mar. 25–May 15.
Cress, upland	Jan. 1–Feb. 1	Jan. 1–Feb. 15	Jan. 15–Feb. 15	Feb. 1–Mar. 1	Feb. 10–Mar. 15	Feb. 20–Mar. 15	Mar. 1–Apr. 1.
Cucumber	Feb. 15–Mar. 15	Feb. 15–Apr. 1	Feb. 15–Apr. 15	Mar. 1–Apr. 15	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 10–May 15.
Eggplant [1]	Feb. 1–Mar. 1	Feb. 10–Mar. 15	Feb. 20–Apr. 1	Mar. 10–Apr. 15	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 15–May 15.
Endive	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Jan. 15–Mar. 1	Feb. 1–Mar. 1	Feb. 15–Mar. 15	Mar. 1–Apr. 1	Mar. 10–Apr. 10.
Fennel, Florence	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Jan. 15–Mar. 1	Feb. 1–Mar. 1	Feb. 15–Mar. 15	Mar. 1–Apr. 1	Mar. 10–Apr. 10.
Garlic	(2)	(2)	(2)	(2)	(2)	Feb. 1–Mar. 1	Feb. 10–Mar. 10.
Horseradish [1]							Mar. 1–Apr. 1.
Kale	Jan. 1–Feb. 1	Jan. 10–Feb. 1	Jan. 20–Feb. 10	Feb. 1–20	Feb. 10–Mar. 1	Feb. 20–Mar. 10	Mar. 1–20.
Kohlrabi	Jan. 1–Feb. 1	Jan. 10–Feb. 1	Jan. 20–Feb. 10	Feb. 1–20	Feb. 10–Mar. 1	Feb. 20–Mar. 10	Mar. 1–Apr. 1.
Leek	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 1–Feb. 15	Jan. 15–Feb. 15	Jan. 25–Mar. 1	Feb. 1–Mar. 1	Feb. 15–Mar. 15.
Lettuce, head [1]	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 15–Feb. 15	Feb. 1–20	Feb. 15–Mar. 10	Mar. 1–20.
Lettuce, leaf	Jan. 1–Feb. 1	Jan. 1–Feb. 1	Jan. 1–Mar. 15	Jan. 1–Mar. 15	Jan. 15–Apr. 1	Feb. 1–Apr. 1	Feb. 15–Apr. 15.
Muskmelon	Feb. 15–Mar. 15	Feb. 15–Apr. 1	Feb. 15–Apr. 15	Mar. 1–Apr. 15	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 10–May 15.
Mustard	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Feb. 15–Apr. 15	Feb. 1–Mar. 1	Feb. 10–Mar. 15	Feb. 20–Apr. 1	Mar. 1–Apr. 15.
Okra	Feb. 15–Apr. 1	Feb. 15–Apr. 15	Mar. 1–June 1	Mar. 10–June 1	Mar. 20–June 1	Apr. 1–June 15	Apr. 10–June 15.
Onion [1]	Jan. 1–15	Jan. 1–15	Jan. 1–15	Jan. 1–Feb. 1	Jan. 15–Feb. 15	Feb. 10–Mar. 10	Feb. 15–Mar. 15.
Onion, seed	Jan. 1–15	Jan. 1–15	Jan. 1–15	Jan. 1–Feb. 15	Feb. 1–Mar. 1	Feb. 10–Mar. 10	Feb. 20–Mar. 15.
Onion, sets	Jan. 1–15	Jan. 1–15	Jan. 1–15	Jan. 1–Mar. 1	Jan. 15–Mar. 10	Feb. 1–Mar. 20	Feb. 15–Mar. 20.
Parsley	Jan. 1–30	Jan. 1–30	Jan. 1–30	Jan. 15–Mar. 1	Feb. 1–Mar. 10	Feb. 15–Mar. 15	Mar. 1–Apr. 1.
Parsnip			Jan. 1–Feb. 1	Jan. 15–Feb. 15	Jan. 15–Mar. 1	Feb. 15–Mar. 15	Mar. 1–Apr. 1.
Peas, garden	Jan. 1–Feb. 15	Jan. 1–Feb. 15	Jan. 1–Mar. 1	Jan. 15–Mar. 1	Jan. 15–Mar. 15	Feb. 1–Mar. 15	Feb. 10–Mar. 20.
Peas, black-eye	Feb. 15–May 1	Feb. 15–May 15	Mar. 1–June 15	Mar. 10–June 20	Mar. 15–July 1	Apr. 1–July 1	Apr. 15–July 1.
Pepper [1]	Feb. 1–Apr. 1	Feb. 15–Apr. 15	Mar. 1–May 1	Mar. 15–May 1	Apr. 1–June 1	Apr. 10–June 1	Apr. 15–June 1.
Potato	Jan. 1–Feb. 15	Jan. 1–Feb. 15	Jan. 15–Mar. 1	Jan. 15–Mar. 1	Feb. 1–Mar. 1	Feb. 10–Mar. 15	Feb. 20–Mar. 20.
Radish	Jan. 1–Apr. 1	Jan. 1–Apr. 1	Jan. 1–Apr. 1	Jan. 1–Apr. 1	Jan. 1–Apr. 15	Jan. 20–May 1	Feb. 15–May 1.
Rhubarb [1]							
Rutabaga				Jan. 1–Feb. 1	Jan. 15–Feb. 15	Jan. 15–Mar. 1	Feb. 1–Mar. 1.
Salsify	Jan. 1–Feb. 1	Jan. 10–Feb. 10	Jan. 15–Feb. 20	Jan. 15–Mar. 1	Feb. 1–Mar. 1	Feb. 15–Mar. 1	Mar. 1–15.
Shallot	Jan. 1–Feb. 1	Jan. 1–Feb. 10	Jan. 1–Feb. 20	Jan. 1–Mar. 1	Jan. 15–Mar. 1	Feb. 1–Mar. 10	Feb. 15–Mar. 15.
Sorrel	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Jan. 15–Mar. 1	Feb. 1–Mar. 10	Feb. 10–Mar. 15	Feb. 10–Mar. 20	Feb. 20–Apr. 1.
Soybean	Mar. 1–June 30	Mar. 1–June 30	Mar. 10–June 30	Mar. 20–June 30	Apr. 10–June 30	Apr. 10–June 30	Apr. 20–June 30.
Spinach	Jan. 1–Feb. 15	Jan. 1–Feb. 15	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Jan. 15–Mar. 10	Jan. 15–Mar. 15	Feb. 1–Mar. 20.
Spinach, New Zealand	Feb. 1–Apr. 15	Feb. 15–Apr. 15	Mar. 1–Apr. 15	Mar. 15–May 15	Mar. 20–May 15	Apr. 1–May 15	Apr. 10–June 1.
Squash, summer	Feb. 1–Apr. 15	Feb. 15–Apr. 15	Mar. 1–Apr. 15	Mar. 15–May 15	Mar. 15–May 1	Apr. 1–May 15	Apr. 10–June 1.
Sweetpotato	Feb. 15–May 15	Mar. 1–May 15	Mar. 20–June 1	Mar. 20–June 1	Apr. 1–June 1	Apr. 10–June 1	Apr. 20–June 1.
Tomato	Feb. 1–Apr. 1	Feb. 20–Apr. 10	Mar. 1–Apr. 20	Mar. 10–May 1	Mar. 20–May 10	Apr. 1–May 20	Apr. 10–June 1.
Turnip	Jan. 1–Mar. 1	Jan. 1–Mar. 1	Jan. 10–Mar. 1	Jan. 20–Mar. 1	Feb. 1–Mar. 1	Feb. 10–Mar. 10	Feb. 20–Mar. 20.
Watermelon	Feb. 15–Mar. 15	Feb. 15–Apr. 1	Feb. 15–Apr. 15	Mar. 1–Apr. 15	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 10–May 15.

[1] Plants.
[2] Generally fall-planted (table 5).

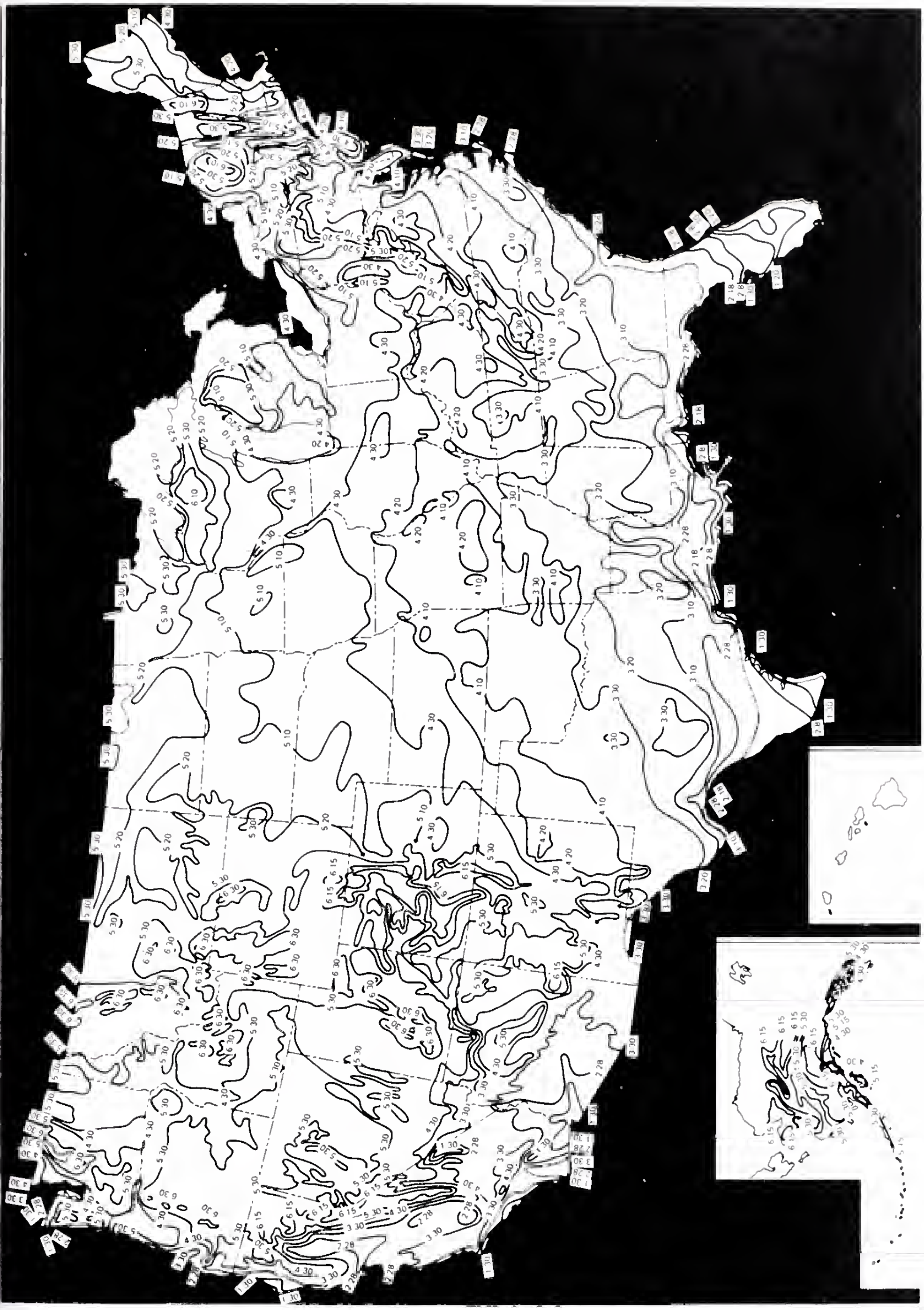

Figure 12.—Average dates of the last killing frost in spring.

TABLE 4.—*Earliest dates, and range of dates, for safe spring planting of vegetables in the open*—Continued

Crop	Planting dates for localities in which average date of last freeze is—						
	Apr. 10	Apr. 20	Apr. 30	May 10	May 20	May 30	June 10
Asparagus [1]	Mar. 10–Apr. 10	Mar. 15–Apr. 15	Mar. 20–Apr. 15	Mar. 10–Apr. 30	Apr. 20–May 15	May 1–June 1	May 15–June 1.
Beans, lima	Apr. 1–June 30	May 1–June 20	May 15–June 15	May 25–June 15			
Beans, snap	Apr. 10–June 30	Apr. 25–June 30	May 10–June 30	May 10–June 30	May–15–June 30	May 25-June 15	
Beet	Mar. 10–June 1	Mar. 20–June 1	Apr. 1–June 15	Apr. 15–June 15	Apr. 25–June 15	May 1–June 15	May 15–June 15.
Broccoli, sprouting [1]	Mar. 15–Apr. 15	Mar. 25–Apr. 20	Apr. 1–May 1	Apr. 15–June 1	May 1–June 15	May 10–June 10	May 20–June 10.
Brussels sprouts [1]	Mar. 15–Apr. 15	Mar. 25–Apr. 20	Apr. 1–May 1	Apr. 15–June 1	May 1–June 15	May 10–June 10	May 20–June 10.
Cabbage [1]	Mar. 1–Apr. 1	Mar. 10–Apr. 1	Mar. 15–Apr. 10	Apr. 1–May 15	May 1–June 15	May 10–June 15	May 20–June 1.
Cabbage, Chinese	(2)	(2)	(2)	Apr. 1–May 15	May 1–June 15	May 10–June 15	May 20–June 1.
Carrot	Mar. 10–Apr. 20	Apr. 1–May 15	Apr. 10–June 1	Apr. 20–June 15	May 1–June 1	May 10–June 1	May 20–June 1.
Cauliflower [1]	Mar. 1–Mar. 20	Mar. 15–Apr. 20	Apr. 10–May 10	Apr. 15–May 15	May 10–June 15	May 20–June 1	June 1–June 15.
Celery and celeriac	Apr. 1–Apr. 20	Apr. 10–May 1	Apr. 15–May 1	Apr. 20–June 15	May 10–June 15	May 20–June 1	June 1–June 15.
Chard	Mar. 15–June 15	Apr. 1–June 15	Apr. 15–June 15	Apr. 20–June 15	May 10–June 15	May 20–June 1	June 1–June 15.
Chervil and chives	Mar. 1–Apr. 1	Mar. 10–Apr. 10	Mar. 20–Apr. 20	Apr. 1–May 1	Apr. 15–May 15	May 1–June 1	May 15–June 1.
Chicory, witloof	June 10–July 1	June 15–July 1	June 15–July 1	June 1–20	June 1–15	June 1–15	June 1–15.
Collards [1]	Mar. 1–June 1	Mar. 10–June 1	Apr. 1–June 1	Apr. 15–June 1	May 1–June 1	May 10–June 1	May 20–June 1.
Cornsalad	Feb. 1–Apr. 1	Feb. 15–Apr. 15	Mar. 1–May 1	Apr. 1–June 1	Apr. 15–June 1	May 1–June 15	May 15–June 15.
Corn, sweet	Apr. 10–June 1	Apr. 25–June 15	May 10–June 15	May 10–June 1	May 15–June 1	May 20–June 1	
Cress, upland	Mar. 10–Apr. 15	Mar. 20–May 1	Apr. 10–May 10	Apr. 20–May 20	May 1–June 1	May 15–June 1	May 15–June 15.
Cucumber	Apr. 20–June 1	May 1–June 15	May 15–June 15	May 20–June 15	June 1–15		
Eggplant [1]	May 1–June 1	May 10–June 1	May 15–June 10	May 20–June 15	June 1–15		
Endive	Mar. 15–Apr. 15	Mar. 25–Apr. 15	Apr. 1–May 1	Apr. 15–May 15	May 1–30	May 1–30	May 15–June 1.
Fennel, Florence	Mar. 15–Apr. 15	Mar. 25–Apr. 15	Apr. 1–May 1	Apr. 15–May 15	May 1–30	May 1–30	May 15–June 1.
Garlic	Feb. 20–Mar. 20	Mar. 10–Apr. 1	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 15–May 15	May 1–30	May 15–June 1.
Horseradish [1]	Mar. 10–Apr. 10	Mar. 20–Apr. 20	Apr. 1–30	Apr. 15–May 15	Apr. 20–May 20	May 1–30	May 15–June 1.
Kale	Mar. 10–Apr. 1	Mar. 20–Apr. 10	Apr. 1–20	Apr. 10–May 1	Apr. 20–May 10	May 1–30	May 15–June 1.
Kohlrabi	Mar. 10–Apr. 10	Mar. 20–May 1	Apr. 1–May 10	Apr. 10–May 15	Apr. 20–May 20	May 1–30	May 15–June 1.
Leek	Mar. 1–Apr. 1	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 15–May 15	May 1–May 20	May 1–15	May 1–15.
Lettuce, head [1]	Mar. 10–Apr. 1	Mar. 20–Apr. 15	Apr. 1–May 1	Apr. 15–May 15	May 1–June 30	May 10–June 30	May 20–June 30.
Lettuce, leaf	Mar. 15–May 15	Mar. 20–May 15	Apr. 1–June 1	Apr. 15–June 15	May 1–June 30	May 10–June 30	May 20–June 30.
Muskmelon	Apr. 20–June 1	May 1–June 15	May 15–June 15	June 1–June 15			
Mustard	Mar. 10–Apr. 20	Mar. 20–May 1	Apr. 1–May 10	Apr. 15–June 1	May 1–June 30	May 10–June 30	May 20–June 30.
Okra	Apr. 20–June 15	May 1–June 1	May 10–June 1	May 20–June 10	June 1–20		
Onion [1]	Mar. 1–Apr. 1	Mar. 15–Apr. 10	Apr. 1–May 1	Apr. 10–May 1	Apr. 20–May 15	May 1–30	May 10–June 10.
Onion, seed	Mar. 1–Apr. 1	Mar. 15–Apr. 1	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 20–May 15	May 1–30	May 10–June 10.
Onion, sets	Mar. 1–Apr. 1	Mar. 10–Apr. 1	Mar. 10–Apr. 10	Apr. 10–May 1	Apr. 20–May 15	May 1–30	May 10–June 10.
Parsley	Mar. 10–Apr. 10	Mar. 20–Apr. 20	Apr. 1–May 1	Apr. 15–May 15	May 1–20	May 10–June 1	May 20–June 10.
Parsnip	Mar. 10–Apr. 10	Mar. 20–Apr. 20	Apr. 1–May 1	Apr. 15–May 15	May 1–20	May 10–June 1	May 20–June 10.
Peas, garden	Feb. 20–Mar. 20	Mar. 10–Apr. 10	Mar. 20–May 1	Apr. 1–May 15	Apr. 15–June 1	May 1–June 15	May 10–June 15.
Peas, black-eye	May 1–July 1	May 10–June 15	May 15–June 1				
Pepper [1]	May 1–June 1	May 10–June 1	May 15–June 10	May 20–June 10	May 25–June 15	June 1–15	
Potato	Mar. 10–Apr. 1	Mar. 15–Apr. 10	Mar. 20–May 10	Apr. 1–June 1	Apr. 15–June 15	May 1–June 15	May 15–June 1.
Radish	Mar. 1–May 1	Mar. 10–May 10	Mar. 20–May 10	Apr. 1–June 1	Apr. 15–June 15	May 1–June 15	May 15–June 1.
Rhubarb [1]	Mar. 1–Apr. 1	Mar. 10–Apr. 10	Mar. 20–Apr. 15	Apr. 1–May 1	Apr. 15–May 10	May 1–20	May 15–June 1.
Rutabaga			May 1–June 1	May 1–June 1	May 1–20	May 10–20	May 20–June 1.
Salsify	Mar. 10–Apr. 15	Mar. 20–May 1	Apr. 1–May 15	Apr. 15–June 1	May 1–June 1	May 10–June 1	May 20–June 1.
Shallot	Mar. 1–Apr. 1	Mar. 15–Apr. 15	Apr. 1–May 1	Apr. 10–May 1	Apr. 20–May 10	May 1–June 1	May 10–June 1.
Sorrel	Mar. 1–Apr. 15	Mar. 15–May 1	Apr. 1–May 15	Apr. 15–June 1	May 1–June 1	May 10–June 10	May 20–June 10.
Soybean	May 1–June 30	May 10–June 20	May 15–June 15	May 25–June 10			
Spinach	Feb. 15–Apr. 1	Mar. 1–Apr. 15	Mar. 20–Apr. 20	Apr. 1–June 15	Apr. 10–June 15	Apr. 20–June 15	May 1–June 15.
Spinach, New Zealand	Apr. 20–June 1	May 1–June 15	May 1–June 15	May 10–June 15	May 20–June 15	June 1–15	
Squash, summer	Apr. 20–June 1	May 1–June 15	May 1–30	May 10–June 10	May 20–June 15	June 1–20	June 10–20.
Sweetpotato	May 1–June 1	May 10–June 10	May 20–June 10				
Tomato	Apr. 20–June 1	May 5–June 10	May 10–June 15	May 15–June 10	May 25–June 15	June 5–20	June 15–30.
Turnip	Mar. 1–Apr. 1	Mar. 10–Apr. 1	Mar. 20–May 1	Apr. 1–June 1	Apr. 15–June 1	May 1–June 15	May 15–June 15.
Watermelon	Apr. 20–June 1	May 1–June 15	May 15–June 15	June 1–June 15	June 15–July 1		

[1] Plants.
[2] Generally fall-planted (table 5).

Molly Adams

Much success with vegetable gardens is due to planting the various crops at the right time according to the temperature in the gardener's locality. The maps and accompanying tables in these pages will aid gardeners all over the country to plant at the right times.

(*Text continued from page* 47)

that has your date over it; and draw a heavy line around this entire column. It is the only date column in the table that you will need.

4. Find the dates in the column that are on a line with the name of the crop you want to plant. These dates show the period during which the crop can safely be planted. The best time is on, or soon after, the first of the two dates. A time halfway between them is very good; the second date is not so good.

For areas in the Plains region that warm up quickly in the spring and are subject to dry weather, very early planting is essential to escape heat and drought. In fact, most of the cool-season crops do not thrive when spring-planted in the southern part of the Great Plains and southern Texas.

Table 5 is used with the map in figure 13 in the same way to find the dates for late plantings. The recommendations for late plantings and for those in the South for overwintered crops are less exact and less dependable than those for early planting. Factors other than direct temperature effects—summer rainfall, for example, and the severity of diseases and insects—often make success difficult, especially in the Southeast, although some other areas having the same frost dates are more favorable. A date about halfway between the two shown in table 5 will generally be best, although in most areas fair success can be expected within the entire range of dates shown.

Along the northern half of the Pacific coast, warm-weather crops should not be planted quite so late as the frost date and table would indicate. Although frost comes late, very cool weather prevails for some time before frost, retarding late growth of crops like sweet corn, lima beans, and tomatoes.

TABLE 5.—*Latest dates, and range of dates, for safe fall planting of vegetables in the open*

Crop	Planting dates for localities in which average dates of first freeze is—					
	Aug. 30	Sept. 10	Sept. 20	Sept. 30	Oct. 10	Oct. 20
Asparagus [1]					Oct. 20–Nov. 15	Nov. 1–Dec. 15.
Beans, lima				June 1–15	June 1–15	June 15–30.
Beans, snap		May 15–June 15	June 1–July 1	June 1–July 10	June 15–July 20	July 1–Aug. 1.
Beet	May 15–June 15	May 15–June 15	June 1–July 1	June 1–July 10	June 15–July 25	July 1–Aug. 5.
Broccoli, sprouting	May 1–June 1	May 1–June 1	May 1–June 15	June 1–30	June 15–July 15	July 1–Aug. 1.
Brussels sprouts	May 1–June 1	May 1–June 1	May 1–June 15	June 1–30	June 15–July 15	July 1–Aug. 1.
Cabbage [1]	May 1–June 1	May 1–June 1	May 1–June 15	June 1–July 10	June 1–July 15	July 1–20.
Cabbage, Chinese	May 15–June 15	May 15–June 15	June 1–July 1	June 1–July 15	June 15–Aug. 1	July 15–Aug. 15.
Carrot	May 15–June 15	May 15–June 15	June 1–July 1	June 1–July 10	June 1–July 20	June 15–Aug. 1.
Cauliflower [1]	May 1–June 1	May 1–July 1	May 1–July 1	May 10–July 15	June 1–July 25	July 1–Aug. 5.
Celery [1] and celeriac	May 1–June 1	May 15–June 15	May 15–July 1	June 1–July 5	June 1–July 15	June 1–Aug. 1.
Chard	May 15–June 15	May 15–July 1	June 1–July 1	June 1–July 5	June 1–July 20	June 1–Aug. 1.
Chervil and chives	May 10–June 10	May 1–June 15	May 15–June 15	(2)	(2)	(2)
Chicory, witloof	May 15–June 15	May 15–June 15	May 15–June 15	June 1–July 1	June 1–July 1	June 15–July 15.
Collards [1]	May 15–June 15	May 15–June 15	May 15–June 15	June 15–July 15	July 1–Aug. 1	July 15–Aug. 15.
Cornsalad	May 15–June 15	May 15–July 1	June 15–Aug. 1	July 15–Sept. 1	Aug. 15–Sept. 15	Sept. 1–Oct. 15.
Corn, sweet			June 1–July 1	June 1–July 1	June 1–July 10	June 1–July 20.
Cress, upland	May 15–June 15	May 15–July 1	June 15–Aug. 1	July 15–Sept. 1	Aug. 15–Sept. 15	Sept. 1–Oct. 15.
Cucumber			June 1–15	June 1–July 1	June 1–July 1	June 1–July 15.
Eggplant [1]				May 20–June 10	May 15–June 15	June 1–July 1.
Endive	June 1–July 1	June 1–July 1	June 15–July 15	June 15–Aug. 1	July 1–Aug. 15	July 15–Sept. 1.
Fennel, Florence	May 15–June 15	May 15–July 15	June 1–July 1	June 1–July 1	June 15–July 15	June 15–Aug. 1.
Garlic	(2)	(2)	(2)	(2)	(2)	(2)
Horseradish [1]	(2)	(2)	(2)	(2)	(2)	(2)
Kale	May 15–June 15	May 15–June 15	June 1–July 1	June 15–July 15	July 1–Aug. 1	July 15–Aug. 15.
Kohlrabi	May 15–June 15	June 1–July 1	June 1–July 15	June 15–July 15	July 1–Aug. 1	July 15–Aug. 15.
Leek	May 1–June 1	May 1–June 1	(2)	(2)	(2)	(2)
Lettuce, head [1]	May 15–July 1	May 15–July 1	June 1–July 15	June 15–Aug. 1	July 15–Aug. 15	Aug. 1–30.
Lettuce, leaf	May 15–July 15	May 15–July 15	June 1–Aug. 1	June 1–Aug. 1	July 15–Sept. 1	July 15–Sept. 1.
Muskmelon			May 1–June 15	May 15–June 1	June 1–June 15	June 15–July 20.
Mustard	May 15–July 15	May 15–July 15	June 1–Aug. 1	June 15–Aug. 1	July 15–Aug. 15	Aug. 1–Sept. 1.
Okra			June 1–20	June 1–July 1	June 1–July 15	June 1–Aug. 1.
Onion [1]	May 1–June 10	May 1–June 10	(2)	(2)	(2)	(2)
Onion, seed	May 1–June 1	May 1–June 10	(2)	(2)	(2)	(2)
Onion, sets	May 1–June 1	May 1–June 10	(2)	(2)	(2)	(2)
Parsley	May 15–June 15	May 1–June 15	June 1–July 1	June 1–July 15	June 15–Aug. 1	July 15–Aug. 15.
Parsnip	May 15–June 1	May 1–June 15	May 15–June 15	June 1–July 1	June 1–July 10	(2)
Peas, garden	May 10–June 15	May 1–July 1	June 1–July 15	June 1–Aug. 1	(2)	(2)
Peas, black-eye					June 1–July 1	June 1–July 1.
Pepper [1]			June 1–June 20	June 1–July 1	June 1–July 1	June 1–July 10.
Potato	May 15–June 1	May 1–June 15	May 1–June 15	May 1–June 15	May 15–June 15	June 15–July 15.
Radish	May 1–July 15	May 1–Aug. 1	June 1–Aug. 15	July 1–Sept. 1	July 15–Sept. 15	Aug. 1–Oct. 1.
Rhubarb [1]	Sept. 1–Oct. 1	Sept. 15–Oct. 15	Sept. 15–Nov. 1	Oct. 1–Nov. 1	Oct. 15–Nov. 15	Oct. 15–Dec. 1.
Rutabaga	May 15–June 15	May 1–June 15	June 1–July 1	June 1–July 1	June 15–July 15	July 10–20.
Salsify	May 15–June 1	May 10–June 10	May 20–June 20	June 1–20	June 1–July 1	June 1–July 1.
Shallot	(2)	(2)	(2)	(2)	(2)	(2)
Sorrel	May 15–June 15	May 1–June 15	June 1–July 1	June 1–July 15	July 1–Aug. 1	July 15–Aug. 15.
Soybean				May 25–June 10	June 1–25	June 1–July 5.
Spinach	May 15–July 1	June 1–July 15	June 1–Aug. 1	July 1–Aug. 15	Aug. 1–Sept. 1	Aug. 20–Sept. 10.
Spinach, New Zealand				May 15–July 1	June 1–July 15	June 1–Aug. 1.
Squash, summer	June 10–20	June 1–20	May 15–July 1	June 1–July 1	June 1–July 15	June 1–July 20.
Squash, winter			May 20–June 10	June 1–15	June 1–July 1	June 1–July 1.
Sweetpotato					May 20–June 10	June 1–15.
Tomato	June 20–30	June 10–20	June 1–20	June 1–20	June 1–20	June 1–July 1.
Turnip	May 15–June 15	June 1–July 1	June 1–July 15	June 1–Aug. 1	July 1–Aug. 1	July 15–Aug. 15.
Watermelon			May 1–June 15	May 15–June 1	June 1–June 15	June 15–July 20.

[1] Plants.
[2] Generally spring-planted (table 4).

Figure 13.—Average dates of the first killing frost in fall.

Mulching materials for the garden

NATURE WAS THE FIRST TO MULCH

D. O. Ezell and E. V. Jones

MULCHING as practiced by gardeners is basically an adaptation of a natural process. Fallen leaves and decaying plant parts occur naturally as mulches. Plants benefit from mulches because moisture and nutrients are conserved, erosion is reduced, weeds are easier controlled, soil temperatures are buffered from rapid changes and fruits don't touch the ground which reduces rotting.

Mulches are usually organic materials but there are a number of synthetic materials that will provide a mulching effect. The following table presents some of the materials commonly used as mulching materials.

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Vegetable garden beds mulched with black plastic. This material has its good and bad points as a mulch. It is excellent for controlling weeds, but offers disposal problems after use and can limit proper acration of the soil during rainy periods.

MULCHING MATERIAL FOR THE GARDEN

Material	Depth to Apply	Remarks
Sawdust	1-2 inches	Should be composted before incorporating into soil. Available around lumber companies, furniture manufacturers, etc.
Wood Chips	3-5 inches	Available from tree service companies. Should be composted before incorporating into the soil.
Wood Shavings	2-3 inches	Available from lumber companies, furniture manufacturers, etc. Should be composted before incorporating into the soil.
Ground Corncobs	2-3 inches	Available in areas where corn is milled. Very good after incorporating for improving soil structure.
Pine Needles	4-5 inches	Often baled and sold as a mulch. Usually clean and free of weeds.
Peanut Hulls	2-3 inches	Available in areas where peanuts are grown and processed.
Cotton Motes	2-3 inches	Usually contain much weed seed but also are high in plant nutrients. Available in cotton and textile areas.
Tobacco Stems	2-3 inches	Must be shredded. Available in tobacco production areas.
Tree Leaves (Whole) (Shredded)	 5-6 inches 2-3 inches	Shredded leaves are more desirable than whole leaves. Collect from neighbors in the fall.
Hay	5-6 inches	Available in agricultural areas, particularly livestock areas.
Grass Clippings	1-2 inches	Save as grass is mowed.
Straw	5-6 inches	Very good garden mulch.
Newspaper	½-1 inch	Ink on newsprint is no problem.
Bark	1-2 inches	Often bagged and sold as a mulch. Can often be obtained in bulk form from lumber or pulpwood yards.
Synthetic Materials:		
Black Plastic (polyethylene)	1 layer	Synthetic materials present problems of disposal after the growing season. These materials don't have a great buffering effect on soil temperature. During prolonged cool, rainy periods, these materials could cause poor aeration around plant roots since they almost completely inhibit evaporation. Weed control excellent.
Wax-coated Paper	1 layer	
Aluminum Foil	1 layer	
Asphalt Spray		
Paper-Polyethylene combinations	1 layer	

For the organic, natural or "run-of-the-mill" gardener

THE SOIL TEST IS THE KEY TO SUCCESS

Robert F. Fletcher and Peter A. Ferretti

Good yields of high-quality vegetables can be expected over a rather wide range of soils. Of course, such variables as amount of rainfall, temperatures, amount of sunlight, soil texture, soil drainage, prevalence and severity of plant diseases, and the vegetable variety have an influence on results.

The more intensive the type of gardening, the more important is the information provided by a soil test. If the garden is being planted for the first time and no knowledge of past soil treatment is available, a test is especially valuable. Most Land-Grant State Universities offer either free soil testing programs or charge a relatively small fee for this service. (See page 72 for a list.) Various private organizations also offer soil-test analyses and fertilizer recommendations for a fee. Contact the Cooperative Extension Service in your particular county, area or region or a fertilizer dealer or supplier for further information on soil-testing services.

Almost all testing services (there may be a few exceptions) will give specific fertilizer recommendations in terms of "x" number of pounds of chemical fertilizer to be applied to a given area (usually 100 or 1,000 sq. ft.) of your garden. The organic gardener must translate these standard chemical recommendations into equivalent amounts of materials which he or she accepts as being "organic" or "natural."

Since no two persons may give the exact same definition for the word "organic," each person must decide what materials will be acceptable. Even so, the suggested amounts of organic or natural materials to be applied in lieu of chemical fertilizer may or may not be equally effective, because of differences in the physical and chemical nature of the materials. Most natural materials are *very* slow to slow in plant nutrient availability when compared to inorganic materials. Tables 2 and 3 give a general rating on the availability of many "natural" and organic materials. Those materials rated very slow to medium in availability may be used to *maintain* a given level and nutrient balance in the soil. Where a rapid change in levels or balance is necessary, the materials having medium to rapid availability should be used. Examples 1, 2, and 3 (following) provide guidelines an organic gardener can use to approach balanced fertility.

Soil-test results reported from the laboratory are often interpreted as low, medium, high or excessive. Crops normally produce best on soils where plant nutrients are present in balanced amounts at medium to high levels. Application of a nutrient shown to be at "low level" should increase yield. Excessive levels indicate that there is more than enough of a nutrient present. Yield and quality are likely to be reduced by applying a nutrient already present in excessive amounts. To achieve maximum yield and quality from each crop, a specific balance among elements is necessary.

Balance and Imbalance of Soil Nutrients

An unbalanced plant-nutrient condition can exist from the use of either organic or inorganic fertilizers. Since most organic materials (including compost) do not contain nutrients in balanced amounts as needed by plants, the addition of other sources of nutrients may be necessary to correct these imbalances. Moreover, similar organic materials can vary considerably in nutrient content—depending on their source, handling, and the conditions present when the plant or organism was living. Ground limestone and other na-

TABLE 1. Natural Materials Used to Decrease Soil Acidity

Clam Shells (finely ground)	50% CaO
Ground Shell Marl (at least 75% shall pass a 100-mesh sieve)	35 to 42% CaO
Oyster Shells (ground)	43 to 50% CaO
Wood Ashes	32% CaO
Limestone (ground limestone is usually accepted in "organic" production)	
Dolomitic	more than 15% MgO + 35% CaO
Calcitic	45 to 50% CaO equivalent

tural materials, in addition to organic materials, should enable users to maintain a nutrient balance in the soil. If the soil test indicates a need for a liming material to correct acidity and increase the calcium and/or magnesium level, the use of these materials is the first step in garden soil management. Table 1 lists materials used to decrease soil acidity. The liming potential of wood ashes (32% CaO) is such that 3 lb of wood ashes is equal to 2 lb of ground limestone (50% CaO). If soil pH is 6.8 or above, wood ashes should not be used. (See also Liming the Garden Soil on page 63.)

Fertilizer Recommendations

Fertilizer recommendations for the production of commercial vegetable crops are expressed as amounts of N (nitrogen), P_2O_5 (phosphate), and K_2O (potash) per acre. Recommendations for garden soils are given in amounts of inorganic fertilizers per 100 square feet (multiply by 435 to covert to lb. per acre). The organic gardener will need to translate these recommendations into terms of the natural materials and organic fertilizers which he has available. The soil testing service does not attempt to give specific recommendations using natural materials and organic fertilizers. This is because the percentage of plant nutrients in such materials is highly variable—usually depending on its source, method of storage (manures), and the amount and type of plant materials used in composting. Generally, the low available-plant-nutrient content and often limited sources of many natural and organic materials adds to the difficulty in developing a specific recommendation.

Phosphorus—A soil with a low phosphorus level may become a real problem in organic as well as natural gardening. Rock phosphate is the most economical "organic" or "natural" source of phosphorus. Raw rock phosphate, even though from high-grade minerals and finely ground, has been quite ineffective on soils with a pH higher than pH 6.0, due to low solubility and exceedingly slow reaction time. Rock phosphate needs acids to bring about the release of its P_2O_5 (phosphate) for plant use; hence it is most efficiently used on acid soils. Although rock phosphate contains 20 to 32 percent P_2O_5, available P_2O_5 is only 5 percent. However, in acid soils the phosphorus may be beneficial to plants in subsequent seasons following application. It would be more efficient to use raw rock phosphate in manure or in making the compost pile, rather than as a soil application. These will then be more balanced nutritionally, and increase the availability of the phosphate. Other sources of P_2O_5 (phosphate) are listed in Tables 2 and 3.

In planning for a future organic garden it would be advisable to apply raw rock phosphate or any other slowly available fertilizer well in advance (at least 6 months to 1 year) of actual planting. If a high initial application of raw rock phosphate is applied, decreasing amounts will be needed in subsequent years. The increase in available phosphorus would be reflected in future soil tests.

Nitrogen and Potash—A number of organic and natural materials may be used to supply N (nitrogen) and K_2O (potash) (Tables 2, 3). Plant-nutrient content of the materials and the relative nutrient availability are listed. The user can make the decision as to which is best

Straw makes an effective mulch for cucumber plants.
George Taloumis

fo: his or her purpose, depending on the materials obtainable.

Soil Preparation

Ideal garden soil is fertile, deep, friable, well-drained, and high in organic matter. Heavy clay soils are late in drying out and are difficult to cultivate and work properly. Extremely sandy soils may lack organic matter and may dry out too rapidly between water applications. The best soil is between these two extremes. The exact type of soil, however, is not too important if it is well-drained, adequately supplied with organic matter, and retains moisture.

The purpose in turning up soil and giving it various pulverizing treatments is to separate soil particles, allow air to come in contact with as many particles as possible, and thereby to provide a favorable medium for roots. Soil must contain air to grow plants; also, beneficial soil bacteria cannot live without it. Poorly drained soil has few air spaces and, therefore, is unproductive.

The deeper the soil is prepared, the greater its capacity for holding air and moisture. Soil should be plowed or spaded to a depth of at least 8 or 9 inches, provided the subsoil is not turned up.

Fall plowing or spading is desirable if coarse organic material, heavy sod, or a heavy application of manure is to be turned under. Coarse organic matter will decompose during fall and early spring. Fall-plowed ground left in the rough over winter dries out quickly so that the seedbed may be prepared and the garden

(Text continued on page 61)

TABLE 2. Mineral Nutrient Value of Natural Deposits Usable as Fertilizers

Materials	N	Percent Nutrients[z] P_2O_5	K_2O	Relative Availability
Colloidal phosphate	0	25	0	Slow
Granite Meal	0	0	3 to 5	Very Slow
Greensand	0	1.35	4 to 9.5%	Very Slow
Kainite	0	0	12	Medium
Rock Phosphate	0	20 to 32	0	Very Slow
Sodium Nitrate	16	0	0	Rapid

[z] The percentage of plant nutrients is highly variable and differs with place of origin. Availability of plant food from natural deposits depends largely upon the fineness to which these materials are pulverized.

TABLE 3. Mineral Nutrient Value of Organic Materials

Materials[z]	N	Percent Nutrients[y] P_2O_5	K_2O	Relative Availability
Animal Tankage (dry)	7	10	0.5	Medium
Bone Meal (raw)	2 to 6	15 to 27	0	Slow
Bone Meal (steamed)	0.7 to 4.0	18 to 34	0	Slow Med.
Cocoa Shell Meal	2.5	1.0	2.5	Slow
Compost (not fortified)	1.5 to 3.5	0.5 to 1.0	1.0 to 2.0	Slow
Cottonseed Meal (dry)	6	2.5	1.7	Slow Med.
Dried Blood (dry)	12	1.5	.57	Med. Rapid
Fertrell—Blue Label	1	1	1	Slow
Fertrell—Gold Label	2	2	2	Slow
Fertrell—Super	3	2	3	Slow
Fertrell—Super "N"	4	3	4	Slow
Fish Emulsion	5	2	2	Rapid
Fish Meal (dry)	10	4	0	Slow
Fish scrap (dry)	3.5 to 12	1 to 12	.08 to 1.6	Slow
Garbage Tankage (dry)	2.7	3	1	Very Slow
Grain Straw	0.6	0.2	1.1	Very Slow
Guano (Bat)	5.7	8.6	2	Medium
Guano (Peru)	12.5	11.2	2.4	Medium
Kelp[x]	.9	.5	4 to 13	Slow
Manure[w] (fresh)				
Cattle	.25	.15	.25	Medium
Horse	.3	.15	.5	Medium
Sheep	.6	.33	.75	Medium
Swine	.3	.3	.3	Medium
Poultry (75% water)	1.5	1	.5	Med. Rapid
Poultry (50% water)	2	2	1.0	Med. Rapid
Poultry (30% water)	3	2.5	1.5	Med. Rapid
Poultry (15% water)	6	4	3	Med. Rapid
Marl	0	2	4.5	Very Slow
Milorganite (dry)	5	2 to 5	2	Medium
Mushroom compost[r]	0.4 to 0.7	57 to 62	0.5 to 1.5	Slow
Peanut hulls	1.5	0.12	0.78	Slow
Peat and muck	1.5 to 3.0	0.25 to 0.5	0.5 to 1.0	Very Slow
Pomaces[v]				
Apple (fresh)	0.17 to 0.3	0.4 to 0.7	0.2 to 0.6	Slow
Apple (dry)	0.7 to 0.9	1.2 to 2.1	0.6 to 1.8	Slow
Castor	5.0	1.0	1.0	Slow
Winery	1.5	1.5	0.80	Slow
Sawdust	4	2	4	Very Slow
Sewage Sludge (activated, dry)	2 to 6	3 to 7	0 to 1	Medium
Sewage Sludge (digested)	1 to 3	½ to 4	0 to ½	Slow
Soybean Meal (dry)	6.7	1.6	2.3	Slow Med.
Tanbark[u]	0	1.5	2	Very Slow
Tomato Processing Sludge[v]	1.0 or less	0.57	0.67	Slow
Tobacco Stems (dry)	2	.7	6.0	Slow
Urea[t]	42 to 46	0	0	Rapid
Wood Ashes[s]	0	1 to 2	3 to 7	Rapid

Footnotes: Where trade names are used, no discrimination is intended and no endorsement is implied. r, Use only after one year of weathering. Fresh mushroom compost is usually too high in soluble salts. s, Potash content depends upon tree species burned. Wood ashes are alkaline, contain about 32% CaO. t, Urea is an organic compound, but it is a synthetic and many organic gardeners prefer not to use it. u, Contains calcium. v, plant nutrients are highly variable, depending on the efficiency and the processing techniques at the processing plant. w, Plant nutrients available during year of application. Varies with the amount of straw and method of storage. x, Contains common salt, sodium carbonates, sodium, and potassium sulfates. y, The percentage of plant nutrients is highly variable; with some materials mean percentages are listed. z, Some of the materials may not be obtainable because of restricted sources.

TABLE 4. Procedure for Converting Fertilizer Recommendations to Pounds of Plant Nutrients per Acre

	Pounds per 100 sq ft		Pounds per Acre Plant Nutrients[z] N	P_2O_5	K_2O
GROUP 1	4.5 lb of 5-10-10[Y]	=	98	200	200
GROUP 2	3.5 lb of 5-10-10	=	76	152	152
	PLUS				
	1.0 lb of 0-20-0	=	0	87	0
			76	239	152
GROUP 3	1.5 lb of 5-10-10	=	33	66	66
	PLUS				
	1.0 lb of 0-20-0	=	0	87	0
			33	153	66

[z] To calculate the amount of material needed for 1 acre from that recommended for 100 square feet, multiply by 435. For example, in Group 1, 4.5 lb of 5-10-10 material is recommended for each 100 square feet of area. By multiplying by 435, the amount needed per acre (1,995 lb) is obtained.

[Y] A commercial fertilizer such as 5-10-10 contains 5 percent N (nitrogen), 10 percent P_2O_5 (phosphate) and 10 percent K_2O (potash). Thus an application of 1,995 lbs of 5-10-10 will provide 98 lbs of N, 199 lbs P_2O_5, and 199 lbs of K_2O per acre. For convenience, calculations are appropriately "rounded."

HOW TO GET THE MOST OUT OF YOUR VEGETABLE-GROWING PROGRAM

- Try to select ground well adapted to the vegetable crops to be grown. However, if less than ideal soil is available, do not despair! Improve what you have with the methods and means suggested throughout this Handbook.
- Be sure the soil is well drained. If your soil is poorly drained, consider raised beds enclosed by boards, railroad ties, cement blocks, etc.
- Use enough lime; do not guess. If you are in doubt, have soil tested. Soil testing leads to more exact liming. Do not over-lime.
- Fertilize adequately but according to directions. Apply fertilizer in a way that will not cause injury but will give highest yields.
- Cultivate to control weeds or apply a mulch. You cannot grow both weeds and good vegetables.
- Where space is available, follow a sound rotation.
- When manure is scarce, improve soil by using green manure crops, cover crops, peat moss, compost materials, or whatever is available locally.
- Practice intercropping as much as practical if land area is restricted. Succession cropping is a good method of getting more vegetables per square foot of garden area.
- Avoid overcrowding of plants.
- Use only the best seed.
- Select disease-resistant varieties.

TABLE 5. USING "NATURAL" OR "ORGANIC" MATERIALS FROM THE SOIL-TEST RECOMMENDATION

EXAMPLE 1. Convert soil test recommendation to actual plant nutrients needed, as illustrated in Table 4.

Refer to Tables 2 and 3 for the percent nutrient values for the various "organic" or "natural" materials. Milorganite, for example, has 5% N (nitrogen), 2 to 5 % P_2O_5 (phosphate), and 2% K_2O (potash). The relative availability of the plant nutrients in this material is "medium." Thus, it would be more desirable than garbage tankage, peat, or sawdust, where their rating is very slow in availability. If Milorganite were applied at 3.5 lb/100 sq ft, it would be equal to about 1500 lb per acre (3.5 x 435). This rate would supply approximately 75-37-30 lb of N-P_2O_5-K_2O per acre. Select other materials (from those suggested in Tables 2 and 3) to supply the remaining plant nutrients.

Material	percent nutrients			lb/acre[z]	lb/acre plant nutrients[z]			lb/100 sq ft[z] equivalent to lb/acre
GROUP 1. For Broccoli, Cabbage and relatives; Tomatoes; Sweet Corn; Beets; Onions; Celery; and Potato								
	N	P_2O_5	K_2O		N	P_2O_5	K_2O	
Milorganite	5	2.5	2	1500	75	37	30	3.5
Wood Ashes	0	1.5	5	3400	0	51	170	8.0
Rock Phosphate[x]	0	5	0	2175	0	109	0	5.0
Dried Blood	12	1.5	.57	217	26	3	1	0.5
				Totals	100	200	201	
GROUP 2. For Vine Crops; Pepper; Eggplant; Raspberry; Asparagus; General Vegetables. (Delete the dried blood used for Group 1 and add the same materials at the following rates)								
Milorganite	5	2.5	2	1500	75	37	30	3.5
Wood Ashes	0	1.5	5	2400	0	36	120	5.5
Rock Phosphate[x]	0	5	0	3300	0	165	0	7.5
				Totals	75	238	150	
GROUP 3. For Beans; Peas; Lettuce; Strawberry; Radish; Watermelon; Turnips.								
Milorganite	5	2.5	2	740	37	19	15	1.75
Wood Ashes	0	1.5	5	980	0	15	49	2.25
Rock Phosphate[x]	0	5	0	2175	0	109	0	5.0
				Totals	37	143	64	

[z] For convenience, some calculations are appropriately "rounded."

[x] Rock Phosphate contains 20 to 35% P_2O_5, but the available P_2O_5 is only about 5% (see "phos-

(*Text continued from page* 58)
planted early in the spring.

Gardens should not be dug up and planted until the soil has dried sufficiently. When pressed tightly in the hand, soil should crumble readily when released; if it forms a compact, muddy mass, it is too wet to be worked. Heavy clay soils which are worked when they are wet lose their crumbly texture; they become hard, compact, lumpy, and consequently unproductive. Several seasons of careful handling are often required to restore such a soil to normal condition and productivity.

No soil should be worked to a fineness that will permit sealing-over during rains. Some heavier garden soils should be left comparatively rough and cloddy to promote aeration and water penetration and reduce crusting of the soil sur-

(*Text continued on page* 63)

Using a rototiller in the vegetable garden can save the home gardener much time and effort.
George Taloumis

EXAMPLE 2. An alternate solution to providing needed plant nutrients with organic and natural materials.

Refer to Tables 2 and 3 for the percent nutrient values for the various "organic" or "natural" materials. Milorganite, for example, has 5% N (nitrogen), 2 to 5% P_2O_5 (phosphate), and 2% K_2O (potash). The relative availability of the plant nutrients in this material is "medium." Thus, it would be more desirable than garbage tankage, peat, or sawdust, where their rating is very slow in availability. If Milorganite were applied at 3.5 lb/100 sq ft, it would be equal to about 1500 lb per acre (3.5 x 435). This rate would supply approximately 75-37-30 lb of N-P_2O_5-K_2O per acre. Select other materials (from those suggested in Tables 2 and 3) to supply the remaining plant nutrients.

	Material	percent nutrients			lb/acre[z]	lb/acre plant nutrients[z]			lb/100 sq ft[z] equivalent to lb/acre
		N	P_2O_5	K_2O		N	P_2O_5	K_2O	
GROUP 1	Bone Meal (steamed)	2.5	26	0	500	12	130	0	1
	Wood Ashes	0	1.2	5	3900	9	58	195	9
	Dried Blood	12	1.5	.57	700	84	10	4	1.75
					Totals	105	198	199	
GROUP 2	Bone Meal (steamed)	2.5	26	0	450	11	117	0	1
	Wood Ashes	0	1.5	5	3000	0	45	150	7
	Dried Blood	12	1.5	.57	550	66	8	3	1.25
	Rock Phosphate[x]	0	5	0	1380	0	69	0	3.00
					Totals	77	239	153	
GROUP 3	Bone Meal (steamed)	2.5	26	0	400	10	112	0	1
	Wood Ashes	0	1.5	5	1350	0	20	67	3
	Dried Blood	12	1.5	.57	200	24	3	1	0.5
	Rock Phosphate[x]	0	5	0	360	0	18	0	1
					Totals	34	153	68	

[z] For convenience, some calculations are appropriately "rounded."

[x] Rock Phosphate contains 20 to 35% P_2O_5, but the available P_2O_5 is only about 5% (see "phosphorus," page 2).

(*Text continued from page* 61)
face.

The best finishing or smoothing tool for the small garden is the iron rake. It is an excellent pulverizer and leveler. Rake stones and bits of rubbish to one side before planting.

Liming the Garden Soil

Most vegetables require at least moderate amounts of lime in the soil to neutralize acid conditions and supply adequate amounts of available calcium for direct nutritional purposes. The only reliable way of finding your soil's pH and calcium needs is a soil test. If calcium is needed but raising the pH is undesirable, substitute twice the amount of agricultural gypsum for the lime.

Liming an acid soil is the first step in attaining its crop-producing potential. When lime is needed, apply it several months ahead of planting time. It is a good practice to apply lime in the fall after harvest. This is especially true where lime is badly needed to correct soil acidity before spring plantings.

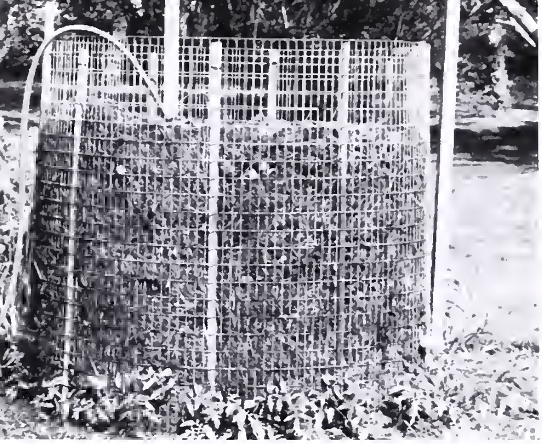
Regardless of how lime is applied, work it thoroughly into the soil. The more completely lime is mixed with soil the more quickly its value is realized. Nutritional deficiencies sometimes occur

EXAMPLE 3. Still another solution to providing needed plant nutrients with organic and natural materials.

	Material	percent nutrients			lb/acre[z]	lb/acre plant nutrients[z]			lb/100 sq ft[z] equivalent to lb/acre
		N	P_2O_5	K_2O		N	P_2O_5	K_2O	
GROUP 1	Poultry Manure 15% moisture	6	4	3	1300	78	52	39	3
	Kelp	.9	.5	13	1250	11	6	152	3
	Bone Meal (steamed)	2.5	26	0	550	14	143	—	1.25
					Totals	103	201	201	
GROUP 2	Poultry Manure 15% moisture	6	4	3	800	48	32	24	1.75
	Kelp	.9	.5	13	950	8	5	123	2
	Bone Meal (steamed)	2.5	26	13	800	20	209	—	1.75
					Totals	76	246	147	
GROUP 3	Poultry Manure 15% moisture	6	4	3	300	18	12	9	.75
	Kelp	.9	.5	13	450	4	2	58	1
	Bone Meal (steamed)	2.5	26	0	500	12	130	0	1
	Rock Phosphate[x]	0	5	0	200	0	10	0	.5
					Totals	34	154	67	

[z] For convenience, some calculations are appropriataely "rounded."

[x] Rock Phosphate contains 20 to 35% P_2O_5, but the available P_2O_5 is only about 5% (see "phosphorus," page 2).



George Taloumis
A compost pile handy to the garden.

in vegetable seedlings when lime is applied and not thoroughly worked into the soil. On soils likely to be deficient in magnesium, the use of dolomitic ground limestone is suggested.

For best results, apply all of the lime recommended by your soil test. Where large applications are made to extremely acid soils, it is important to distribute lime throughout the tilling or plowing depth. For applications up to 9 pounds per 100 square feet, plow down or broadcast lime after plowing. With applications of 14 pounds per 100 square feet, it is desirable to plow down half and add the other half after plowing. With applications of 18 pounds per 100 square feet, it is very important that half be plowed down and the remainder applied after plowing to avoid injury from an overconcentration.

The limestone used to enrich the quality of compost is another means of maintaining the proper calcium level in garden soils.

Organic Matter for Soil Improvement

Organic matter or humus is the most effective material for improving all kinds of soil. Humus, strictly speaking, is the result of the decay of organic materials.

Organic matter or humus may be added to garden soils in the form of manure, compost, peat moss, peat-humus, spent mushroom compost, and sawdust. Organic matter can be grown in the gardent in the form of winter cover crops, green manure crops, or sod when the land is not used for gardening. A legume-grass mixture is an effective green manure crop for improving soil.

In most home gardens, cropping is intensive, with two or three crops per year. When garden soils receive no organic materials the soil organic matter will steadily be lost and the physical condition of the soil will become worse.

Thus, a combination of moderate manuring and medium applications of a complete fertilizer is most effective in producing high yields of top-quality vegetables. Buy manure if it is available at a reasonable price. Make a compost pile of leaves, grass clippings, etc. Green manure or winter cover crops can be grown but you might have to depend on properly selected fertilizers for a balanced supply of nutrients.

SEEK ADVICE ON SOIL PROBLEMS EARLY

IT IS better to seek assistance before or while a crop is growing, if possible. This is especially true when plant growth is unsatisfactory, since surviving plants often provide a clue to the cause of the trouble. To wait until the vegetable has been removed and the garden is being prepared for the next crop is wasting time as well as destroying valuable evidence. Symptoms shown by a growing plant often give a county agent or any other trained observer evidence of probable plant food deficiency. Information on past planting, fertilization, manuring, liming and drainage can also be a help in solving soil problems.

The soils are generally alkaline

NATURAL GARDENING IN DRY CLIMATES

Ricardo E. Gomez

THE majority of soil-improvement instructions for natural gardeners have been developed for the moist climatic areas of the United States. We read and hear how lime and wood ashes improve soil through the improvement of tilth and nutrient availability. However, if these recommendations were to be applied to the arid regions of the Southwest, chaos could result!

The desert or arid soils of the Southwest are generally alkaline and the addition of alkaline materials such as lime and wood ashes would only cause the deterioration of, or at best be of no value to, the soil. The soils in this region, as well as most of the water, have large amounts of salts. Any addition of materials contributing to an increase in soil salinity hampers production in the vegetable garden.

Manures, a good source of organic matter and nutrients in other parts of the country, are also beneficial in southwestern soils. However, some of them, especially from feed lots, contain large amounts of salts. This type of manure should be used with some restraint and ought not to be applied shortly before the planting season in our area. The best time to incorporate manures is in the autumn of the year prior to spring planting.

The soils of the Southwest have a very low organic matter content—between .5 and 1.5 percent—making them very susceptible to desiccation as well as to leaching of nutrients with irrigation water. They are also characterized as being of almost pure sand or of very heavy clay (adobe).

Few of these soils are suitable for gardening without the addition of organic matter. They are hard to manage but the risks involved can be minimized by proper handling prior to growing plants.

The following practices can help you improve the soil and have a more productive garden in dry areas. These recommendations are governed by the need of plants for a porous, well-aerated soil to supply water and nutrients and by such needs as irrigation and a correctly balanced nutrient supply.

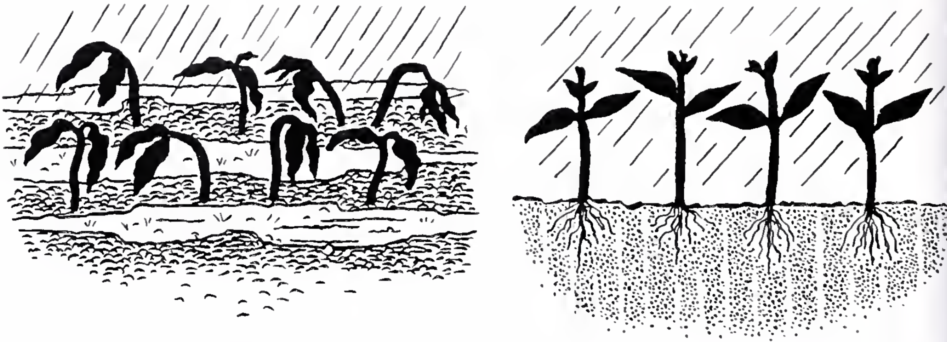
Fertilization

Composted or aged steer manure (or equivalent amount from other source) should be applied in the autumn prior to spring planting at a rate of 1 lb. per square foot and incorporated to a depth of 6 to 8 inches. Manure will supply all of the potassium needs, some of the phosphorus and most of the nitrogen.

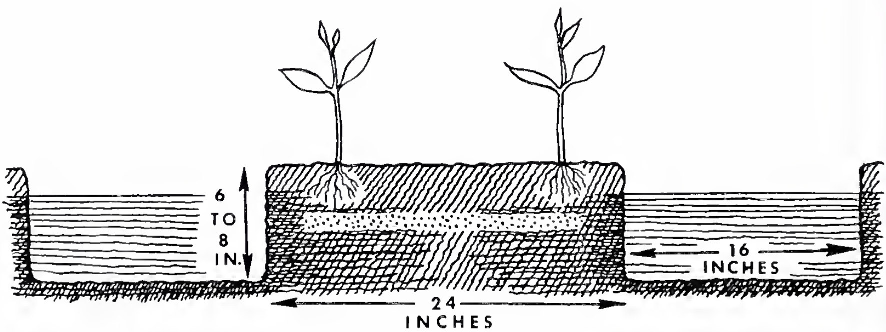
A preplant addition of phosphorus is a "must." Organic gardeners can use rock phosphate or bone meal for this purpose. These materials should be banded for a greater efficiency.

Extra nitrogen may be needed, especially for vegetables and other garden plants with long growing periods. If a manure 'tea' is used, care should be taken since it is a solution that contains high amounts of salts. Blood meal or other nitrogen sources can also be employed.

Try this technique to avoid salt injury to plants: Raise the garden beds to allow for furrow irrigation. Different-size beds can be used but one standard size can accommodate all of your vegetables. The beds should be about 24 inches wide with a furrow 16 inches wide and 6-8 inches deep. This size bed coupled with furrow irrigation helps to reduce salt injury. Water moves the salt to the center of the bed; therefore, the



Healthy seedlings, right; unhealthy seedlings, left, are result of crusted soil and salt accumulations from improper irrigation.



Drawings by Eva Melady

Raising the garden beds to avoid salt injury in furrow irrigation.

crops should *not* be planted in that area. However, the areas away from the center will be less salty and plants can safely be seeded there. Phosphorus should be banded about 3 inches below the surface of the bed and about the same distance from the side.

For furrow irrigation, maintain water level 2 or more inches below the seed row. If the seed row is covered with water, the soil surface will form a crust through which small-seeded vegetable plants cannot emerge. Keep water in the furrows until it reaches the center of the bed. If water goes only to the seed row and no farther, the seed row becomes the point of greatest salt accumulation, and germination may be inhibited.

Straw mulches help retain soil moisture in southwestern gardens but they should not be applied 8 or 10 inches thick, as they sometimes are by organic gardeners in other parts of the country. In a dry climate there are not really very many disease problems, but root rot can occur if plants are mulched excessively. It is better to use a thin layer—just a couple of inches of straw or other bulky material. If these are unavailable, old newspapers or black polyethylene (poly film) are satisfactory substitutes. To lessen the chance of damping off, apply the mulch after seedling plants have emerged and are getting established.

Finally, a word about chlorosis, a common affliction in alkaline-soil areas, which are frequently deficient in iron. This malady is easy to diagnose by leaves that are yellow, green being present only around the veins. Chlorosis is more often observed among ornamental plants and long-season vegetables than in short-season ones. A foliar spray of iron chelates quickly controls it, or one may use a ground application of iron sulfates.

The problem of mass food production

A PLANT SCIENTIST LOOKS AT ORGANIC GARDENING

John Carew

THERE are a number of ways to garden; hydroponically, scientifically and organically, just to name a few. Land grant universities and other academic institutions do not advocate one method over another but endeavor to provide information for people so that their gardening efforts may be more successful.

Both the *science* and the *art* of horticulture are taught. Within the science of horticulture, we deal with how plants grow; how the composition and yield of plants are influenced by plant nutrients; and how plants are influenced by their environment. The information taught has been gained through many years of research and is based on scientific evidence.

In sharp contrast, when teaching the *art* of horticulture, it is recognized that personal opinion is more important than scientific data. Accordingly, we stress the importance of preference; preference for crop varieties, for tastes and colors, or for one garden practice over another. One of the many joys of gardening is the opportunity to be as scientific or as artistic as you like.

Gardeners are generally aware that most scientists and educators view the organic gardening movement with mixed emotions. The display of interest in protecting our environment is welcomed, as is the vigor with which people spade soil and build compost piles. In fact, it is genuinely pleasing to anyone who teaches horticulture to see millions of people, young and not so young, become home gardeners. Let it also be said that the emphasis on organic matter and crop rotation as important factors in plant growth are supported completely by scientific evidence.

At the same time there are disturbing aspects about the organic gardening movement. Among them are the claims made that food grown the "organic way" is more nutritious than food grown with properly used chemical fertilizers and pesticides. There are no valid data to support these contentions. (See page 37.) It is also distressing when we read that "organically" grown plants will not be attacked by insects and diseases. This is a misleading half-truth.

A greater concern, however, is when some groups attempt, through legislative means, to impose their gardening lifestyle on the rest of society, or when attempts are made to have chemical fertilizers or pesticides banned or curtailed. Such action can be contrary to the welfare of millions of people in the United States as well as in other parts of the world.

Two Sides

Those of us who have enjoyed working with organic gardeners for many years believe the controversy has two sides (which often are overlooked in the heat of argument):

On one side is organic gardening as a *way of home gardening*. For many people it is challenging, exciting and rewarding to mind and body. They find great personal satisfaction in raising a garden and, unaided by pesticides, to achieve even partial success in repelling diseases and insects. Gardening, after all, is a hobby and each person is free to do it the way he or she chooses.

On the other side is organic gardening as a *technique for producing food*. Here, organic gardening has serious limitations. Compared with scientific food-growing procedures where chemical fertilizers and pesticides are used in conjunction with sound soil-management practices, it usually results in food of no higher nutritive value but with a higher incidence of disease and insect blemishes and at a cost considerably higher in human labor.

The expanded enthusiasm for organic gardening apparently originates in part from a public belief that farmers, processors, doctors and agricultural experiment stations have placed too much dependence on chemicals to solve their problems; chemicals to feed plants, to control pests, to regulate flowering and fruiting and to preserve and fortify food.

People often express the wish that their lives and their food could be "more simple, more natural and more chemical free." They learn that it is not too difficult to raise some kinds of vegetables in their home garden without pesticides and they would like to have their supermarket food grown in the same way. There is a strong emotional appeal to such an idea.

But before going too far in this direction, think first of the alternatives. Be aware that without chemical fertilizers our food production capacity and the quality of our diet would drop drasticall People would line up for food as the have for gasoline. This is exactly wh millions will do in countries unable t make or import enough fertilizer.

Let us also refresh our memories c food quality in the days before moder pesticides; the wormy sweet corn, th scabby apples and the epidemics c blights and insects that impaired bot food quality and quantity.

Homeowners who grow plants withou chemicals, who place their faith in com post piles and in the biological control c pests, don't have to be particularly cor cerned with production efficiency in thei own vegetable garden or with blemishe caused by insects and diseases. If mor tomatoes are needed, more tomatoes ar planted. If there is an ear worm on swee corn, cut it off. That's part of gardenin But the farmers and their families wh grow food commercially for our nationa needs cannot succeed if they are limite to specialized home gardening prac tices.

Eva Melad

"I can't help it. The Handbook says to use fish emulsion."

Not all good—not all bad

SEWAGE SLUDGE: BENEFITS AND PROBLEMS

Rufus L. Chaney

From a presentation at the 5th Annual Meeting of the Delaware-Maryland Plant Food Association. Baltimore, Nov. 6-7, 1973.

SEWAGE sludge (the solid fraction separated during purification of the water in sewage) contains plant nutrients and organic matter which can improve soils and crops. Sludge is a good soil conditioner, increases water-holding capacity, infiltration rates and tilth of most soils.

Thus, sewage sludge looks too good to be true—a free source of fertilizers and organic matter! But, as one might expect, there are also problems and environmental hazards related to land application of sewage sludge.

A U.S.D.A. group at Beltsville (Maryland), workers at the University of Illinois and others have compiled the following list of potential problems:

Temporary Problems

Excess N (nitrogen)
Excess P (phosphorus)
Odors
Pathogens
Initial toxicity
Handling

Persistent Problems

Excess toxic elements
Need for pH management

The conservation of sludge N is greatest if one applies liquid digested sludge to the surface of grass pastures, a practice used with good results at Hagerstown, Maryland, for 22 years. If sludge application rates are restricted to crop requirements, no nitrate leaches to ground water. Composted sludge appears to constitute no hazard of nitrate leaching.

Sludge contains more P that crops need. Because sewage authorities now must remove nearly all the phosphorus from sewage water, the sludge is becoming even richer in phosphorus. Questions remain about the availability of sludge P from these new processes. Phosphate toxicity could be a temporary problem with crops very sensitive to excess phosphate if high rates of sludge are applied. Odor is a practical problem. Well-digested sludges, mixed well into the soil surface at fertilizer rates, usually do not produce undesirable odors. If the sewage treatment plant is having trouble with its digesters, however, odor problems can arise. Odor from sludge mixed into the soil is much less than that from surface-applied manures. Composted sludge causes no odor problem. The urban homeowner can use composted sludge and still be accepted by his neighbors.

Anaerobic digestion of sewage sludge destroys most of the human pathogens, and is generally considered biologically safe to use on farm crops without further treatment. Digested sludge does contain low levels of pathogenic bacteria, viruses and parasites. Heat-dried activated sludge or pasteurized sludge is considered safe. Composted sludge is considered essentially as safe as pasteurized sludge because the prolonged heat of composting kills pathogens. Pathogens added with sludge die off with time. At the present time we would not recommend growing crops that are to be eaten raw during the first year of sludge application unless the sludge is disinfected by pasteurization or composting.

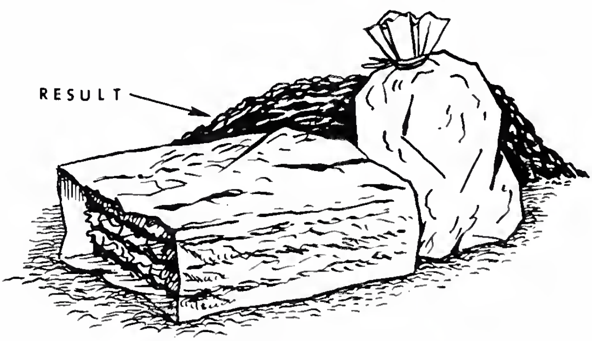
A problem of crop injury that we call "initial toxicity" is a combination of ammonia toxicity, salt toxicity and organic toxicity. This problem occurs during the first one to two months after high rates of sludge are mixed into the soil. Seeds do not germinate; seedlings wither and die. Established pastures treated with liquid sludge at low N fertilizer rates show no injury, only growth response. Composting largely removes this potential for initial toxicity.

The ease of handling of the sludge materials is an important aspect of farm use. Composted sludge, at least as produced at Beltsville, is a relatively dry (60-80 percent solids), easy-to-handle soil conditioner. High rates can be applied and tilled with farm equipment. It can be stored until needed. Composted sludge could be made available inexpensively in bulk to landscapers or farmers, if loaded into their trucks at a distribution site.

Though we can manage land application sites and application rates to control the temporary hazards from N, P, organic matter and pathogens, the toxic heavy metals (the results of industrial pollution, such as from viscose rayon manufacture, metal plating, etc.) will accumulate and/or persist, thus becoming *the* long-term hazard to the environment. One of the reasons sludge is applied on land is the ability of soils to adsorb toxic metals and phosphate, thus preventing their leaching and contaminating surface and ground waters. Metal levels are low in sludge from municipalities that have no metal industries and from those that adequately regulate dumping of metal wastes into their sewers.

One of the factors controlling metal toxicity to plants is the pH of the sludge-amended soil. The toxic metals are much more available at pH's below 6.5-7. A high soil metal content that may be completely safe at pH 7 can be lethal to most crops at pH 5.5. Adding sludge (but not compost) usually leads to a lower soil pH, but this reduction can be corrected if necessary by applying lime.

COMPOST—SANDWICH—IN—A—BAG



Eva Melady

TRASH BAG COMPOSTING

EASY "anywhere" composting has been made possible by plastic bags. The 32-gallon garbage can liners are especially useful in the fall when garden debris and leaves are so plentiful. A couple of shovelfuls of plant wastes are put in the bag and sprinkled with fertilizer and lime (omit the lime if making compost for acid-soil plants). This is repeated until the bag is full, then about a quart of water is added and the bag is tied tightly. Fast decomposition, space saving and no need to turn the "heap" are advantages of this method—and the bags can be stored in the cellar or heated garage where cold will not slow the composting action.—*The Avant Gardener* (Vol. 5, No. 16)

Cornell University

A WAY TO MAKE COMPOST

A CONVENIENT composting program is to make a new pile every year starting with the spring cleanup. During the following summer organic wastes are built into the pile as they accumulate. To start the pile a layer of roughage about 6 inches deep is spread on the ground. The size of the pile is determined by the amount of material anticipated. Six by 10 feet is a practical size. To promote decay nitrogen is required. This may be supplied by a layer of animal manure or by spreading over the surface a high nitrogen fertilizer (10-6-4), about 1/2 pound to 100 square feet of surface. Good practice is to add ground limestone at the same rate and a shovelful of garden soil to assure the presence of the decay organisms. The pile is built up with successive layers treated as described above, usually topping off with the fall garden cleanup and a quantity of leaves. It is important to moisten the materials uniformly. If the pile becomes hot and gives off steam it should be cooled with additional water.

The following spring, after a month or more of warm weather, the pile should be forked over and rebuilt to make sure that the decay is taking place uniformly and to moisten the material that is too dry. At summer's end or early the following spring, the compost can be used on the garden as a mulch or incorporated into the soil. If uniform, fine-textured compost, comparable to peat, is wanted, an additional summer season and forking over again is advisable. This greatly reduces the bulk of the compost but improves its texture. —*L. H. MacD.*

STATE SOIL TESTING LABORATORIES

PLANTS growing poorly? Much grief can be avoided by having a soil sample tested from time to time. For information on how to prepare and submit a sample, contact your county agent or write to your state agency listed below. A nominal fee is usually charged, but the results can help you have a better garden.

Soil Testing Laboratory
Auburn University
Auburn, Alabama 36830

Soil Testing Laboratory
Institute of Agricultural Sciences
Palmer, Alaska 99645

Cooperative Extension Service
University of Arizona
Tucson, Arizona 85721

Soil Testing Laboratory
University of Arkansas
Fayetteville, Arkansas 72701

Soil Testing Laboratory
Dept. of Soil and Plant Nutrition
University of California
Davis, California 95616

Soil Testing Laboratory
Cooperative Extension Service
Colorado State University
Fort Collins, Colorado 80521

Soil Testing Laboratory
Box U-102
University of Connecticut
Storrs, Connecticut 06268

Soil Testing Laboratory
University of Delaware
Newark, Delaware 19711

Soil Testing Laboratory
Florida Agricultural Extension Service
University of Florida
G159 McCarty Hall
Gainesville, Florida 32601

Soil Testing & Plant Analysis Laboratory
2400 College Station Road
Athens, Georgia 30602

Soil Testing Laboratory
University of Hawaii
2525 Varney Circle
Gilmore Hall
Honolulu, Hawaii 96822

Soil Testing Laboratory
College of Agriculture
Agricultural Experiment Station
Moscow, Idaho 83843

Soil Testing Laboratory
Agronomy Department
University of Illinois
Urbana, Illinois 61801

Plant & Soil Analysis Laboratory
Department of Agronomy
Purdue University
Lafayette, Indiana 47907

Soil Testing Laboratory
Iowa State University
Ames, Iowa 50010

Soil Testing Laboratory
Kansas State University
Waters Hall
Manhattan, Kansas 66502

Soil Testing Laboratory
University of Kentucky
Division of Regulatory Service
Lexington, Kentucky 40506

Soil Testing Laboratory
Agronomy Department
Louisiana State University
Baton Rouge, Louisiana 70803

Soil Testing Laboratory
Dept. of Plant & Soil Sciences
University of Maine
Orono, Maine 04473

Soil Testing Laboratory
Cooperative Extension Service
University of Maryland
College Park, Maryland 20742

Soil Testing Laboratory
Dept. of Plant & Soil Sciences
Stockbridge Hall
University of Massachusetts
Amherst, Massachusetts 01002

Soil Testing Laboratory
Michigan State University
East Lansing, Michigan 48823

University of Minnesota
Soil Testing Laboratory
St. Paul, Minnesota 55101

Soil Testing Laboratory
Dept. of Agronomy-Soils
Drawer NY
State College, Mississippi 39762

Soil Testing Laboratory
Agronomy Department
University of Missouri
Columbia, Missouri 65201

Soil Testing Laboratory
Agricultural Experiment Station
Bozeman, Montana 59715

Soil Testing Laboratory
125 Keim Hall
University of Nebraska
Lincoln, Nebraska 68503

Soil Testing Laboratory
Plant, Soil and Water Science Division
Max C. Fleischman College of Agriculture
Reno, Nevada 89507

College of Agriculture
Analytical Services Laboratory
University of New Hampshire
Durham, New Hampshire 03824

Soil Testing Laboratory
P.O. Box 231
Rutgers—The State University
New Brunswick, New Jersey 08903

Soil Testing Laboratory
Cooperative Extension Service
New Mexico State University
Box 3AE
Las Cruces, New Mexico 88001

North Carolina Department of Agriculture
Soil Testing Division
Raleigh, North Carolina 27602

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North Dakota State University
Fargo, North Dakota 58102

Soil Testing Laboratory
Townsend Hall
Ohio State University
1885 Neil Avenue
Columbus, Ohio 43210

Soil Testing Laboratory
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Oklahoma State University
Stillwater, Oklahoma 74075

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Cooperative Extension Service
Oregon State University
Corvallis, Oregon 97331

College of Agriculture
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Pennsylvania State University
University Park, Pennsylvania 16802

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University of Rhode Island
Kingston, Rhode Island 02881

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Dept. of Agronomy and Soils
Clemson University
Clemson, South Carolina 29631

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Brookings, South Dakota 57006

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Morgantown, West Virginia 26506

Soil and Plant Analysis Laboratory
University of Wisconsin
Madison, Wisconsin 53706

Soil Testing Laboratory
University Station
P.O. Box 3354
Laramie, Wyoming 82070

WEED CONTROL IN THE HOME GARDEN

A HANDBOOK

- Gardening Without Weeds
- Ideas for Naturalistic Landscaping
- Weed-free Lawns in Any Climate
- Weed Control With Chemicals

BROOKLYN BOTANIC GARDEN RECORD

PLANTS & GARDENS

Vol. 31 No. 2
(Summer 1975)

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

WEED CONTROL IN THE HOME GARDEN

Vol. 31 Summer (August) 1975 No. 2

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From Common Weeds of the United State

Hemp (*Cannabis sativa*), the source of marijuana and hashish, is a tall annual weed nativ to Asia and now grows wild over much of the United States. The flowers on both mal and female plants are green. The male plant turns brown after shedding its pollen bu female plant remains dark green until killed by frost. **A** and **a**, male plant and growt habit; **b**, enlarged staminate flower panicle; **c**, flower; **B** and **a**, female plant and growt habit; **b**, enlarged pistillate flower cluster; **c**, flower; **d**, achene; **e**, seeds (enlarged).

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Nine years have passed since the last Botanic Garden Handbook on Weed Control, and the time has come for a new treatment. It's not that the weeds have changed all that much, though there is more *Veronica filiformis*, a pretty little escape from rock gardens, and a yellow daisy from the Midwest, *Verbesina helianthoides*, has suddenly appeared in numbers in the waste spots around New York's Kennedy Airport. This is more or less in the nature of things, for nature is never quite static. A flower bed left untended for several weeks will quickly confirm that fact, as all seasoned gardeners know.

But there are new herbicides and new uses for them, and attitudes toward them have evolved. It wasn't too many years ago that many gardeners regarded herbicides as a panacea, and the common dandelion of lawns was attacked with a very special vengeance. Often enough, the other aspects of turf renewal were ignored, and in the succeeding year crabgrass romp occurred in the spots vacated by the dandelion—thus necessitating even more herbicides!

The widespread use of these chemicals led to abuse, and now a generation more concerned with the environment has learned to be more cautious. Obviously, however, not everyone has received the message, and Contributor Jane McKinnon recently dropped us a line about an unthinking soul who sprayed his wife's entire vegetable garden with 2,4-D. Ms. McKinnon graciously spared us the wife's remarks, which in any event couldn't reach print. As members of the Weed Science Society would confirm, it happens every day.

Yes, indeed, there is an organization called the Weed Science Society of America, and the Botanic Garden is fortunate to have it as a collaborator on this issue. Its members are a bit nervous these days, understandably so in view of the evolving herbicide regulations and uncertainty about future Environmental Protection Agency controls. In fact, for its legal protection the Society has asked us to stress that it can't be responsible for the suggestions of its particular members. This in no way diminishes from our contributors' remarks. They are cautious people, for they have seen much. Let us thank these experienced professionals, leaders in their field, for taking the time and effort to give a current look at the weed scene.

Why herbicides at all? It's true that most garden weeds can—and should—be controlled by the time-honored hand-and-knee-and-wipe-thy-brow method. Let it be understood that low-maintenance gardening isn't no-maintenance gardening! However, the successful control of poison-ivy, bindweed, Japanese honeysuckle and certain other banes of the homelot can be accomplished only by chemical means. Properly used (and this cautionary note appears throughout the Handbook), herbicides have an appropriate place.

Keep things in proportion when you are striving to do in the henbit. And take time out on a nice day to admire a roadside of chicory. The flowers are perhaps the finest blue nature has to offer.

Frederick McGourty, Jr.

Editor

Note: Trade names are sometimes used in this Handbook as an aid to the reader. The omission of other trade names of similar herbicides is unintentional. The use of a trade name does not imply endorsement and exclusion does not mean nonapproval.

When does a plant become a weed?

WEEDS AND THEIR CONTROL

Gerald R. Miller

WHEN people decided that certain kinds of plants met human needs better than others, those less-favored plants became weeds. By controlling the less-favored and improving the desirable species, people have increased the supply of food and fiber many fold, improved the appearance of living areas, and avoided many irritations and nuisances of weedy plants.

What Is A Weed?

Weeds have been variously defined as:

1 Plants out of place.
2 Plants growing where they are not wanted.
3 Plants which interfere with people's use of land for a specific purpose.
4 Plants, which in a particular place at a particular time, so arouse human dislike that attempts are made to eradicate or control them.

Plants may be disliked for many reasons. Some plants are irritating or poisonous, while others cause allergic reactions or harbor diseases and insects. Plants are classified as weeds when they obstruct vision or compete with more desirable plants for light, water, nutrients and space.

Desirable plants are those that produce more edible parts than others, or, for general landscaping purposes, are more attractive. In the case of lawns they provide a longer period of ground cover during spring, summer and fall seasons as well as persisting from year to year.

Thus a plant becomes a weed often as a result of its location and what is desired for that location rather than because of its genus and species. A plant which is a weed in one area may be a pleasant wildflower elsewhere. Many of these wild plants serve various useful functions in nature, such as reducing erosion, providing food and cover for wildlife and furnishing nutrients and compost in the decaying stages. Even the ubiquitou dandelion that is despised by the suburb anite trying to maintain a uniform law of grass is favored by others for its leave in salads and for its blossoms used i preparing a wine.

Types of Weeds

Proper identification of weeds is essenti to planning control practices. Weeds a commonly grouped into grassy weeds an broadleaved weeds. But this grouping not specific enough to use in selectin modern chemicals for control. Positiv identification of a specimen can be a tained by comparison with pictures c specimens in a herbarium, turning to book with botanical keys, or simply b consultation with a person who know plants.

Understanding the growth cycle c weeds will also assist in planning contr methods that will attack the plants whe they are in a susceptible phase of growt Weeds have annual, biennial or perenni growth habits. Annuals complete the life cycle in less than one year, usuall growing from seed in the spring and pro ducing seed in the summer or fall. Cral grass and common ragweed are annual A variation of this cycle is shown b winter annuals which germinate in th fall, live through winter and comple their cycle with seed production in th spring. Annuals maintain their popul tions by producing large numbers c seeds. Only a small percentage of the va seed population in the soil germinat each year. The remainder remains do mant to germinate in succeeding year Control programs for annuals are d signed to eliminate the young seedlin and to prevent seed production.

Biennials require two seasons to con plete their growth and reproducti

WEED SCIENCE SOCIETY OF AMERICA

The Weed Science Society of America (WSSA) is grateful to Brooklyn Botanic Garden for the opportunity to provide technical assistance and contribute articles to this publication. WSSA is an organization of 1,700 members who are individuals and organizations interested in the study and control of weeds. Through their efforts in controlling undesirable plants, WSSA members promote improved production of food and fiber and help create a healthier and more attractive environment for man, domestic animals and wildlife.

The Society was organized in 1956 to promote the development of knowledge concerning weeds and their control; to foster unity in research, legislation, regulation and terminology; to encourage high standards in weed science education; and to facilitate publication of weed science information. WSSA now publishes *Weed Science,* a scientific journal, and *Weeds Today,* a popular publication. Information is available from the WSSA Executive Secretary, 113 North Neil Street, Champaign, Illinois 61820.

cycles. A vegetative stage develops the first season: usually the root stores food and overwinters, then the following season new vegetative growth and flowers and seeds are produced. This kind of plant is more easily controlled during the first year of vegetative growth. Examples are wild carrot, bull thistle and mullein.

Perennials live two years or more. Common examples are Canada thistle, dandelion, quackgrass, nutsedge and johnsongrass. Such weeds, in addition to producing seeds, reproduce and persist by vegetative structures such as bulbs, tubers, corms, budding roots, rhizomes and stolons. These multiple reproductive mechanisms make perennials especially difficult to control. In addition to destroying top growth and preventing seed production, the underground portions must also be eliminated by using cultural practices and suitable chemicals.

Methods of Control

Effective weed-control programs usually include the use of a combination of methods that will encourage the desirable plants while bringing maximum pressure against the undesirable—the weeds.

Preventing weeds is the ideal approach to avoiding a lot of hard work and discouragement later. Preventive control measures include:

1 Use of clean seed.
2 Preventing weeds from going to seed.
3 Avoiding use of manure unless weed seed viability has been destroyed by fermentation.
4 Keeping border areas free of weeds.
5 Cleaning equipment to remove weed seeds and vegetative parts before taking the equipment into clean areas.
6 Avoiding use of soil or compost that is infested with weeds.
7 Inspection of nursery stock for weed seeds or vegetative parts of perennial weeds.

Maintaining ideal growing conditions for the desired plants is probably the best way to control weeds. Weeds are able to compete vigorously for limited supplies of nutrients and water. Usually there is a weed species that is adapted to and able to persist in such areas where various deficiencies have resulted in the disappearance of desirable plants. By using good gardening practices—selecting plants and their varieties that are adapted to the soil conditions and geographic area and maintaining soil and growing conditions as ideal as possible, you give the chosen plants a competitive advantage over weeds.

Cultivating the soil and mowing are effective weed-control practices that are less of a chore today because of mechanized tillers and mowing machines. Mulches are also useful for weed control, especially in home gardens. However, hand weeding of flower beds and other limited-area plantings is still the most practical method of weed control in most home gardens.

Controlling weeds with biological organisms, such as insects and diseases, has been successful in only a few instances, mostly in range and aquatic environments. These organisms are not practical for weed control around home properties.

Role of Herbicides

Herbicides are chemicals that control weed growth. Actually they may be considered a form of pesticide, with weeds being the pest controlled.

Since 1950, the technology of herbicide use has been greatly expanded to the point that these chemicals are now in general use for food and fiber production. Much of the increased productivity of agriculture in this country during the last 25 years can be attributed to the use of herbicides. For the homeowner, herbicides also have eliminated much of the tedious labor required in gardening and maintaining an attractive landscape. But the effectiveness of an herbicide is largely dependent on the user. An understanding of herbicides will help you to use them effectively and safely.

For a chemical to be effective as an herbicide, it must be toxic against plants, a characteristic described as herbicidal activity. An herbicide which is active against most kinds of plants is referred to as a non-selective chemical. Such chemicals are useful in areas where complete control of vegetation is desired. Most herbicides for use in lawns and gardens are selective, that is, the chemical is more toxic to some plants than others and, therefore, by using a proper rate, susceptible weeds can be removed from tolerant plants. But, if excessive rates are used, the tolerance may be exceeded with injury to the crop or desired plant the result. Each kind of flower, fruit and vegetable varies in its tolerance to a specific herbicide. In the home garden this specificity can mean that several herbicides will be required for safe use among all the different kinds of plants involved—and to control different kinds of weeds.

Herbicides in the Soil

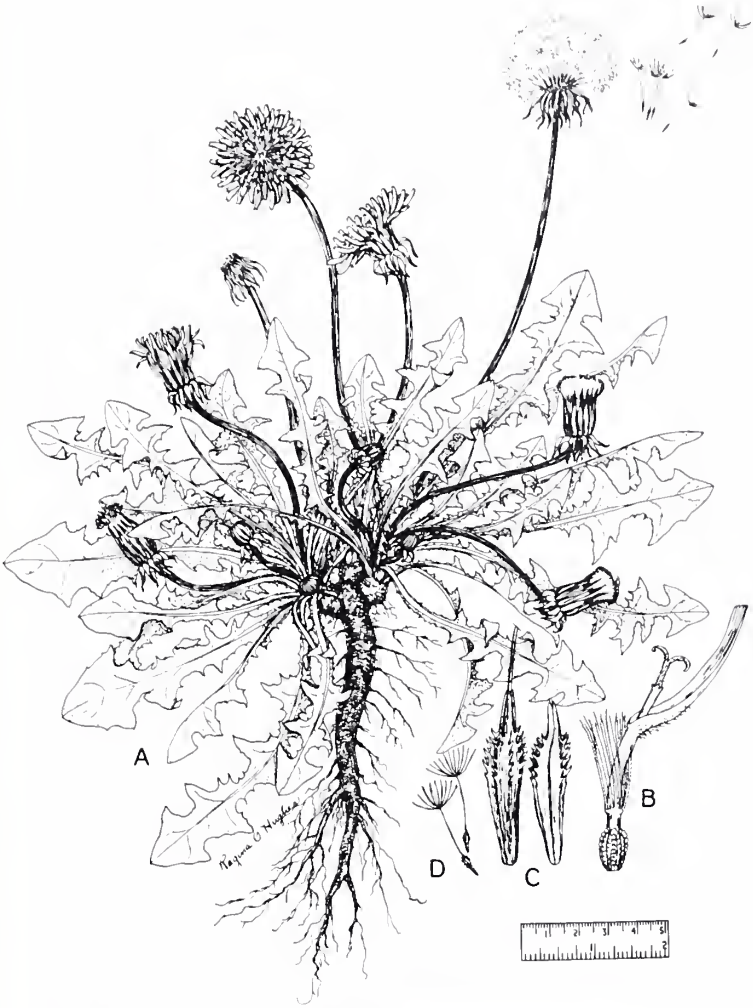
Herbicides are applied to the soil and to the foliage of growing plants. Soil-applied herbicides act on the germinating seeds and young seedlings. So to be effective, they must persist during the time when the weed seeds are germinating.

Chemicals used for long-term vegetation control may persist for two or more years, but most chemicals last only a few days to a few weeks in the soil. However, some chemicals may remain in the soil in sufficient amounts to affect susceptible crops planted the next year. For herbicides applied to the soil to be effective, conditions must be favorable for the chemical to be taken up by the germinating weed root or young shoot. The activity of herbicides in the soil is therefore greatly influenced by the soil texture, amount of organic matter in the soil, soil acidity and moisture conditions.

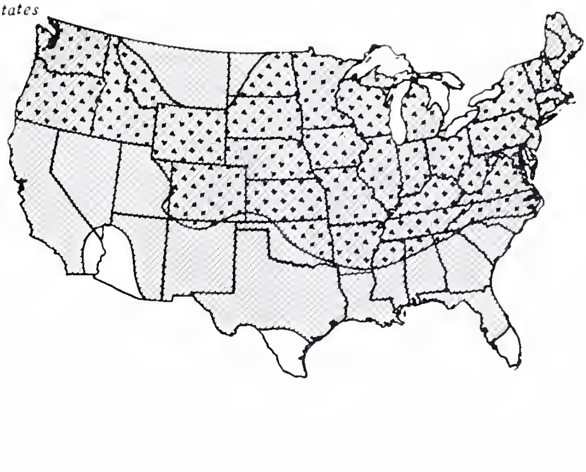
Foliar Applications

For a chemical to be effective when applied to foliage, it must be retained on the leaf surface, penetrate into the leaf through a waxy surface barrier and then move within the plant to an active site where it causes a toxic effect. Some herbicides applied to the foliage simply have a contact or burning effect on the foliage and are not moved within the plant. Other chemicals are translocated to the growing points—buds, leaves and root tips—and are effective in killing both above-ground and below-ground parts of the plants. Such translocated herbicides are effective against perennial weeds with vegetative reproductive parts below the soil surface.

Selectivity of foliar-applied herbicides depends on the varying responses of the



From Common Weeds of the United States



Probably the dandelion is thought of first when weeds are mentioned, yet it has its devotees—for home-made wine (flowers) and for steaming like spinach or serving fresh in salads (foliage). A, habit; B, flower; C, achenes; D, achenes with pappus. Map shows its wide distribution over most of the United States.

plant's foliage for retention, uptake, or translocation, or to chemical reactions of the herbicide within the plant. Such varying responses can result from differences in plant structures as obvious as the degree of hairiness of leaf surfaces, the depth of the root system, or the location of the growing points. Or the different response may be due to subtle differences in the chemical reactions that occur within the plant, whereby one plant can detoxify a chemical while a susceptible plant cannot break down the herbicide and is killed.

Applying Herbicides

Herbicides may be applied at different times according to the emergence time of the weed and desirable plant or crop:

1 Preplanting treatments are applied before the crop is planted and usually mixed into 2 to 3 inches of soil.

2 Preemergence treatments are applied after the crop is planted, but before the crop or weeds emerge.

3 Postemergence treatments are applied after the crop and/or weeds have emerged above the soil surface and are growing.

The degree of success with herbicides can be markedly affected by environmental conditions. With the great differences in weather conditions, it is remarkable that chemical weed control is so successful.

Wind may cause improper distribution of herbicides and increase drift. To avoid problems you should apply chemicals when the wind velocity is low and blowing away from sensitive plants.

Herbicides are usually most effective when temperatures before application have favored uniform weed germination and rapid growth. Young, vigorous, rapidly growing weeds are easiest to kill. High temperatures at the time of application generally increase the activity of herbicides. This improves weed control but also increases the risk of crop or desirable plant injury. Moderate temperatures, ranging from 70° to 85°F are generally most favorable for spray applications.

Activity of soil-applied herbicides is enhanced by moderate rain or irrigation shortly after application to move the chemical into the weed seed germinating zone and to stimulate uniform germination of the weed seeds. Heavy rainfall shortly after a foliar spray of an herbicide may wash the chemical from the leaves before it is taken up. Usually effectiveness is not reduced if there is an interval of a few hours between applications and rainfall.

High or moderate humidity increases the effectiveness of most herbicide applications to foliage. When the air is moist, more herbicide penetrates the leaves and more weeds are killed. Crop injury may also be more of a problem under high humidity conditions.

High temperatures and moist soil also favor decomposition of herbicides in the soil. Herbicides are decomposed by microorganisms and chemical reactions in the soil. These decomposition processes prevent the build-up of herbicides.

Herbicide Formulations

Most herbicides are purchased as commercial formulations for particular ways of application. Herbicides are formulated:

1 For mixing with a liquid carrier, usually water, and applying with a sprayer or other liquid dispenser. These formulations include water-soluble liquids, emulsifiable concentrates and water-dispersible liquids.

2 For distribution with mechanical spreaders or by hand. These include granules and pellets that are applied dry as purchased.

3 For injecting into the soil for vaporization or fumigation.

(Powders for direct application are generally not used for herbicides because of drift problem.)

In addition to the herbicide, formulations include other ingredients to improve handling, to facilitate mixing, to make the chemical adhere to leaf surfaces and to increase wetting of plants. Some formulations contain inactive ingredients to dilute the product. Granular formulations and pellets are often diluted with carriers to facilitate uniform application rates.

Labels on the containers include a statement that lists the amount of active ingredient in the formulation. The amount of active herbicide in the product is stated as a percentage of active ingredient or acid equivalent for dry formulations and in pounds per gallon for liquids. This information is important for understanding the proper rate of application for a commercial product. The cost per pound of active herbicide is one of the best guides to use in comparing the value of different formulations of the same herbicide.

Some formulations of 2,4-D are volatile and the vapors from areas treated with these formulations can injure susceptible plants. Only low-volatile formulations should be used in the home garden.

Laws for Pesticide Use

Fortunately, most herbicides are much more toxic to plants than to people or animals. However, through misuse and careless handling, accidents can occur. Label instructions include information for preventing accidents and measures to follow in case an accident occurs.

The use of pesticides, including herbicides, is regulated by the U.S. Environmental Protection Agency (EPA) under legislation known as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and amended in 1972 by the Federal Environmental Pesticide Control Act (FEPCA). This legislation is designed to enable the Federal Government to protect people and the environment from hazards caused by the misuse of pesticides.

FIFRA requires that all pesticides must be registered with EPA before they can be sold. Before a product can be registered, the manufacturer is required to provide scientific evidence that the product when used as directed will effectively control the pest(s) listed on the label; not injure people, crops, livestock, wildlife, or damage the total environment; and not result in illegal residues in food or feed. Registered products have an EPA registration number on the label.

The Federal Food, Drug, and Cosmetic Act provides protection to consumers from harmful pesticide residues in food. This act requires that a tolerance or legal limit be established for any residues that might remain in or on a harvested food or feed crop as a result of the application of a chemical for pest control. Tolerances are based on chemical and toxicological data showing that the residues are safe for consumption.

The use of any registered pesticide in a manner inconsistent with the labeling instructions is prohibited. Civil and criminal penalties for misuse of pesticides are provided in FEPCA and are applicable to the home user as well as others.

In the future, products will be classified for general or restricted use. Products for general use will be available for application by anyone. But, restricted products can be applied only by a certified applicator. In addition, many states have special registration requirements and restrict the use of some pesticides. Check your state and local regulations regarding pesticide use.

Safety First

Herbicides are relatively safe to use as intended and as stated on labels. But precautions must be followed to avoid overexposure to the user or exposure of organisms which should not come in contact with the chemicals. Take the extra time and make the extra effort required to follow proper safety measures when buying, storing or applying herbicides and disposing of leftover chemicals or empty containers. Accidents result from carelessness and misuse. The following guidelines offered by the Environmental Protection Agency and U.S. Department of Agriculture will help you to avoid problems.

Study and follow the label before purchasing an herbicide and before each time you use it. Do not rely on your memory. Ask these questions:

1 Is the product registered for the use you intend? Don't use it on a vegetable or ornamental that is not listed on the label.

2 Does it control the kinds of weeds you want to eliminate?

3 Are there restrictions on use around the home?

Guide to Storing

Improper storage is the most frequent cause of injury to people from herbicides and most of these accidents involve children under 5 years of age. Proper storage is not difficult:

1 Store in a locked cabinet in a well-ventilated area outside the home. Never put pesticides in cabinets with or near food, medical supplies or cleaning materials.
2 Store herbicides in the original container with the label that lists ingredients, directions for use, and antidotes in case of accidental poisoning. Never transfer pesticides to soft drink bottles or other containers that children associate with something to eat or drink.
3 Store pesticides immediately when you bring them home and after each use.
4 Buy only what you need and do not mix more than you need so there is not a lot of material stored around your home.

Techniques for Application

Protect yourself and others by following proper application techniques.

1 Wear clothing that covers your arms and legs and whatever protective clothing the label suggests.
2 Mix chemicals outdoors in a well ventilated area.
3 Keep children and pets away from areas where you mix and apply pesticides. Clean up any spills promptly.
4 Don't smoke, eat, or drink while applying pesticides. The chemicals can be carried from hand to mouth. Some formulations are flammable.
5 Wash thoroughly with soap and water immediately if you spill chemicals on your skin and when you have finished before engaging in other activities.
6 Avoid prolonged inhalation of pesticide sprays, vapors or dusts.
7 Launder clothing before wearing them again. If you spill them on clothing, remove the clothing and wash the skin. Wear rubber boots when spraying to avoid getting your shoes contaminated with chemicals.

Protect Desirable Plants

1 Select the right herbicide for the plants you want to protect.
2 Apply herbicides at the proper rate and time and use the proper method of application. Do not exceed the recommended rates.
3 Avoid drift by using low-drift formulations, low-spraying pressures, large volumes of coarse sprays, and by spraying when the wind velocity is low and blowing away from nearby sensitive crops. Do not apply herbicides when the temperatures exceed 90°F.
4 Avoid applying non-selective, complete vegetation control chemicals to the foliage or over the root zone of desirable plants where leaching of the chemical into the soil may result in plant injury.
5 Avoid applying herbicides or cleaning application equipment on sloping bare ground, pavement, or other areas where the herbicide may be carried by runoff to valuable plants or aquatic sites.
6 Do not use a sprayer previously used for applying herbicides for other purposes on crop or ornamental plants.
7 Do not store herbicides near seeds, bulbs, fertilizer, fungicides or other lawn and garden supplies.

Protect the Environment

1 Dispose of empty containers promptly and properly. Rinse all containers three times and use the rinse water in your sprayer. Residues left in empty pesticide containers can lead to accidents.

Wrap single, empty pesticide containers in several ıayers of newspaper and tie securely. Then put them in a covered trash can if you have collection service. If you do not, empty containers should be crushed and then buried in a sanitary land fill or at least 18 inches deep in a place on your land where there is no danger of contaminating water. *Do not, however, puncture pressurized containers.* Normally, you should not burn pesticide containers since the vapors from some materials can be harmful.

2 Never pour leftover pesticides down the sink or toilet bowl. Chemicals may interfere with the operation of septic systems or contaminate waterways.

3 Avoid spillage of herbicides, disposal of pesticide containers, or cleaning of equipment near wells, streams, ponds and lakes or in areas frequented by wildlife or inhabited by fish.

Protect Yourself and Others

If an accident occurs, take immediate action. If you get a pesticide in your eyes, flush them with water for 15 minutes and call a doctor. If someone accidentally swallows a pesticide, check the label for antidote and first-aid instructions. Call a doctor. Read him the label. Take the labeled container with you if you go to the doctor or hospital.

HERBICIDE SAFETY GUIDELINES

—Get the proper herbicide for your weed problem and for the plants you are protecting.
—Read the label.
—Store it securely.
—Apply it properly.
—Clean up thoroughly.
—Dispose of empty containers safely.

Eva Melady

"I guess we should have read the label."

Many weeds are invaders from abroad

THE SILENT TRAVELERS

John M. Fogg, Jr.

WEEDS, no matter how they are defined, are so familiar even to non-gardeners that it is startling to realize that most of the plants considered as weeds in the eastern United States are not native there, but have come from other continents or from other sections of our own continent.

More than 12½ per cent—1,041 species—of the flowering plants and ferns of the central and northeastern United States and adjacent Canada have been introduced from elsewhere. As covered in the comprehensive *Gray's Manual of Botany,* these are their places of origin:

Europe	692	species
Eastern Asia	121	"
Eurasia	111	"
Tropical America	66	"
Central and western North America	44	"
Others (Africa, South America, etc.)	7	"
Total	1,041	"

While not all of these may qualify as weeds, a goodly number are, and some (to be considered later) have become aggressive pioneers. If weeds among strictly native plants are also counted, a rough estimate gives 1,200 species of weeds in the area considered. This is about 14 per cent of the total number of species in Gray's Manual.

The European Element

The overwhelming predominance of European species in our weedy flora has long been recognized and is easily understood. Among these nearly 700 kinds, it is highly instructive to note that 420 (or approximately 60 per cent) belong to the following seven plant families:

Composite family (Compositae) (dandelion, hawkweed, bull thistle, Canada thistle)	112	species
Grass family (Gramineae) (Bermuda grass, timothy, crabgrass, annual bluegrass)	65	"
Mustard family (Cruciferae) (penny-cress, pepperwort, shepherd's purse, mustard)	62	"
Mint family (Labiatae) (ground-ivy, horsemint and most other mints)	60	"
Pea family (Leguminosae) (clover, sweet clover, vetch)	54	"
Pink family (Caryophyllaceae) (chickweed, mouse-ear chickweed, bouncing Bet)	37	"
Figwort family (Scrophulariaceae) (mullein, butter-and-eggs, speedwell)	30	"

A significant feature of this list is that practically all of the genera in these families (at least in temperate regions) are herbaceous; that is, they are perennials, biennials or quick-growing annuals, rather than woody plants.

A second feature (not unrelated to the first) is that these families, in general, are regarded by the botanist as of recent evolutionary origin, in contrast to such ancient families as the magnolia (Magnoliaceae), barberry (Berberidaceae), laurel (Lauraceae), moonseed (Menispermaceae), custard-apple (Annonaceae) and others, which are primarily woody and which have made almost no contribution to the influx of weeds. If, as some botanists believe, modernity implies aggressiveness of pioneering vigor, then it

; not surprising that the seven herbaceous families listed above should constitute such an impressive bloc of European immigrants.

Still another feature is their ability to produce enormous quantities of small seeds or, in the case of the composites (hawk-weeds, dandelions, thistles, etc.), achenes which are equipped with tufts of hairs or bristles which greatly facilitate dissemination by wind.

The various means whereby European plants have contrived their passage to the New World have been so often described that only the briefest summary will be offered here; obviously, some were aided by human agency (intentional), while others got here on their own (inadvertent).

Intentional Introductions. To this category belong plants which were transported across the Atlantic Ocean by early colonists for one or more of the following reasons:

(a) Ornamentals: Plants such as cypress spurge *(Euphorbia cyparissias),* mullein-pink *(Lychnis coronaria),* bouncing Bet *(Saponaria officinalis),* yellow toadflax or butter-and-eggs *(Linaria vulgaris)* and many others were introduced into the New World as attractive and familiar garden plants. All have escaped from cultivation and have become widely naturalized in our eastern flora. Today, they are generally looked upon as weeds.

(b) Forage and Grazing Plants: Numerous species of grasses important to livestock and such plants as alfalfa, clovers and vetch were brought to this country by early settlers and are now universally distributed.

(c) Vegetables: Many European culinary species, especially those from the Mediterranean area, were early transported to the New World. The list is long but includes, among others, radish, turnip, carrot and parsnip. All of these have escaped to become dominant weeds along roadsides and in open fields, vacant lots and farmlands.

(d) Condiments or Kitchen Herbs: This group includes such favorite and important seasoning plants as marjoram, basil, hyssop, thyme, caraway, dill, fennel, tarragon, mustard and countless others, not to mention such an indispensable pot-herb as purslane *(Portulaca oleracea),* which has become one of our most pernicious weeds.

(e) Medicinal Plants: Early immigrants brought with them many familiar home remedies. Many of these, such as henbane *(Hyoscyamus niger),* have all but disappeared from our flora but others, like elecampane *(Inula helenium),* have invaded widespread fields and pastures.

Inadvertent Introductions. To this group belongs the great majority of European adventives, or plants that have become naturalized. They arrived as stowaways in the rigging of ships, as impurities in shipments of grain and other seeds, in packing materials, on agricultural implements, but perhaps most prolifically in ship's ballast. In the early days a sailing vessel with a light cargo filled its hold with soil which was shoveled overboard at the first port-of-call, such as Boston, New York, Philadelphia, Baltimore, Charleston or one of the other eastern harbors. In this manner the seeds of hundreds of European species were introduced into Atlantic North America. The list of such adventives is prodigiously long and includes, to mention only a token few, many weedy grasses (such as crabgrass and goosegrass), wild garlic, the docks, many of the chickweeds and knotweeds, a host of mustards (including winter cress, pepper-grass and shepherd's-purse), bindweed, blueweed, hemp-nettles, several mulleins, common plantain, ribgrass, bedstraws and such ubiquitous composites as whiteweed, burdock, thistles, chicory, dandelion, sow-thistle, hawkweeds and the despised devil's paintbrush.

In passing, it must be emphasized that these modern, aggressive species from the open, sunny habitats of south-central Europe might never have gained a foothold in the New World had man left the country in the condition in which he found it, namely, that of deep, almost impenetrable forest. Instead he cut down the trees, ploughed the soil (thus upsetting century-old horizons), built villages, planted farms, laid out roads and railways and installed harbors. In short, he created exactly the kinds of habitats in which these visitors from abroad could readily establish themselves and from which they could rapidly spread throughout practically all of eastern North America.

Eastern Asia's Contribution

In marked contrast to those plants which have come from Europe, the species which have been naturalized from eastern Asia are mostly denizens of woodlands, rather than of open sunny situations. For this reason they tend to be restricted in this country to shaded habitats, instead of fields, roadside banks, fallow farms and vacant lots. One of the most conspicuous and at the same time most pernicious of these species is the Japanese honeysuckle *(Lonicera japonica)*, which has taken over thousands of square miles of our eastern woodland, in many cases almost completely exterminating our original herbaceous vegetation. Another, though less obnoxious, example is the wineberry *(Rubus phoenicolasius)*, a raspberry relative which may be found in almost any piece of native woodland throughout the Middle Atlantic States. The Japanese hop *(Humulus japonicus)*, unlike its European cousin, has made itself abundantly at home in the eastern United States, mostly in shaded situations, during the last two or three decades. Within a similar period a small annual knotweed from southeastern Asia (called *Polygonum caespitosum longisetum*) has undergone a phenomenal spread and is now found along woodland trails and in damp shaded spots from Massachusets to Delaware and west to Kentucky and Illinois. The oriental bittersweet *(Celastrus orbiculata)* has become almost as abundant as its American cousin in many thickets and bottomlands. Several Asiatic trees have invaded our eastern forests and mingled with our native species; chief among them are the tree-of-heaven *(Ailanthus altissima)* and the princess- or empress-tree *(Paulownia tomentosa)*; and south of Washington the silk-tree *(Albizia julibrissin)* and the chinaberry *(Melia azedarach)* are considered weed trees.

Return from the Tropics

A million or so years ago, most of eastern North America enjoyed a climate far milder than that of the present—a climate which supported a warm temperate or sub-tropical vegetation. Then came the continental ice sheets and all that was changed. Since the retreat of the Wisconsin Ice, about 11,000 years ago, our climate has undergone progressive, though intermittent, amelioration and many groups of plants, such as the oaks, have been slowly migrating northward to reoccupy their former northern distributions. It is therefore perhaps not surprising that more than 60 species of plants from Tropical America should have insinuated themselves into our weedy community. Most of them are annuals, the seeds of which are capable of surviving our severe mid-northern winters.

Among them are Mexican-tea *(Chenopodium ambrosioides)*, spider-flower *(Cleome spinosa)* and bristly-mallow *(Sida spinosa)*. Several kinds of morning-glory *(Ipomoea)* abound and one of the most prevalent and persistent is the carpet-weed *(Mollugo verticillata)*. The champion invader of them all, however, is a little annual, hairy galinsoga, which is perhaps better known by its botanical name *Galinsoga ciliata*.

Invasion from the West

The existence in the eastern United States of more than two score of plants from central and western North America is comparable to the presence here of so many species from the modern flora of southern Europe. In both instances the destruction of the original forests has facilitated the invasion of aggressive, sun-loving plants which are quick to take advantage of the artificial habitats which man has provided for them. The list includes several grasses from the plains and prairies, a scattering of pigweeds, mustards, legumes, evening-primroses, nightshades, the winged-pigweed *(Cycloloma atriplicifolium)*, and, as one might expect, a fair representation of Compositae belonging to such genera as *Grindelia, Ambrosia* and *Rudbeckia*. It is difficult to

Photographs by George Taloumis

The tenacious habits of the tree-of-heaven (*Ailanthus altissima*) are well known to most city dwellers who may not be aware that this tree is now common in rural areas and along the coast (**below**). **Above, left:** A grove of the trees (self-sown) in a familiar urban setting and, **right,** one tree that appears to have grown out of concrete to frame a townhouse.

imagine that such sun-lovers as evening-primroses *(Oenothera)* and black-eyed-Susan *(Rudbeckia serotina)* or even the common ragweeds *(Ambrosia)* were common in eastern North America, before the cutting of the forests created the open, sunny situations in which they have proliferated. The opening of highways and railroads has also greatly expedited the migration of prairie plants into our eastern states.

Native Weeds

It must not be concluded from all that has been said above that eastern North America is totally lacking in its own weedy flora. By their very genetic constitution some species are more aggressive, faster-growing, more drought-resistant or better equipped for rapid propagation and dispersal than others. Thus it happens that such native eastern species as poison-ivy *(Rhus radicans),* bindweed *(Convolvulus sepium),* honewort *(Cryptotaenia canadensis),* horse-nettle *(Solanum carolinense)* and horseweed *(Conyza canadensis)* must be considered as weeds along with plants introduced from other regions.

Step-by-step methods for

GROWING A HEALTHY LAWN

W. H. Daniel and R. P. Freeborg

WEED-INFESTED, unhealthy lawns are a nuisance to homeowners. Weed control can be obtained through the maintenance of a healthy, dense turf and the use of chemicals.

The following seven steps to a healthy, weed-free lawn were developed from 20 years of work with turf. You may be interested in all seven or only a part of the steps. A variety of products are available to accomplish your task. A good soil for adequate moisture and nutrient storage will support all steps.

STEP 1. Use Grasses Adapted to Your Climate

Bluegrasses are favorites throughout the cool season grass area. Older varieties such as 'Newport', 'Delta', 'Park', 'Merion', and 'Windsor' are still available. Newer varieties such as 'Sydsport', 'Victa', 'Sodco', 'Adelphi', 'Baron', 'Bonnieblue', 'Fylking', 'Pennstar' and 'Nugget' bluegrasses may have low-growth characteristics, a broader range of disease resistance, or be more vigorous. These improved selections are mixed to give greater disease resistance and vigor. Redtop or ryegrasses are often added for early growth. Red fescue may be added for shade. Always buy the best seed based on purity and bluegrass percentages.

STEP 2. Mow Regularly at Proper Height

Bluegrass lawns will withstand disease damage and weed competition better if cut to a 2-inch height than if cut closer. Newer, more disease-resistant selections can be cut at 1 to 1½ inches. Bentgrass, zoysia and bermudagrass should be cut to less than 1 inch.

Keep the mower blades sharp. Sharpening the blade of the rotary mower at least once a month favors a clean cut and less damage to grass leaves.

Before each mowing with reel-type mowers check the reel to be sure it gives a complete cut of the leaf as the blade passes the bed-knife. File the front edge of the bed-knife at least once a month to insure a sharp cutting edge. Grass blades cut with a dull mower begin regrowth slowly and are more susceptible to stress from hot or dry weather.

STEP 3. Fertilize Two or More Times Annually

The maintenance of an ample nutrient supply is important to the development of a dense, healthy, weed-free turf. A lawn is a mixture of dead, dying and growing blades of grass. Green leaves must predominate. Adequate nutrients to provide a daily supply are suggested. The practice of ample nutrition is important to developing healthy dense turf to keep weed invasion to a minimum. Minor elements including iron, manganese, zinc and sulphur are usually available in satisfactory amounts. Some specialty fertilizers include small amounts of minor elements to allow for unusually high pH or wet soil conditions. But the most important elements are nitrogen (N), phosphorus (P) and potassium (K). These are contained in complete fertilizers. The number of applications and quantities of nutrients required will depend on local soil and climate conditions.

As a general guide, feed the lawn twice a year using fertilizer high in nitrogen, low in phosphorus and medium in potash content. For example a fertilizer with 16 percent total nitrogen, 4 percent available phosphorus, and 8 percent soluble potash is labeled as 16-4-8. This fertilizer has a ratio of 4:1:2. Some other widely available fertilizers include: 23-7-7, 16-8-8, 24-4-12 and 10-3-7.

Grasses use large amounts of nitrogen and the amount of nitrogen applied to a lawn will regulate its growth if all other nutrients are available in ample supply.

emoving with the mower the ower heads of dandelions before ney set seeds is one way to reduce neir population. However, since andelions are perennials, permanent emoval is only achieved by igging up the sturdy tap root or praying the plant with a herbicide.

George Taloumis

Nitrogen deficiencies are indicated by ight green color, poor growth and thin- ess of turf.

Many lawn fertilizers today are non- urning, slow release, light-weight granu- ar types. They can be applied with a ush-type spreader when grass leaves are lry without damage. Water turf immedi- tely after fertilizer applications for quick esponse and to prevent damage to grass.

STEP 4. Irrigate

awns should be watered as the soil be- ins to dry out, before the grass wilts and as a chance to become brown. An early lue to wilt is the appearance of a dark luish-green cast caused partly by leaf olding. Footprints may remain when the urf is walked on. Most turf will go lormant about three days after wilt first ccurs. Wilted, dormant turf is suscepti- le to weed invasion.

Water as little as practical in spring nd early summer to favor deep rooting, ut as summer progresses and wilting oc- urs, water as needed to prevent severe vilt and resulting dormancy. These pro- edures reduce potential weed invasion in hin turf.

STEP 5. Prevent Insect Damage

nsect control is easy and often unneces- ary. But, knowing what to do is impor- ant. Insects may seriously injure or dis- igure lawns, causing thin turf to be subject to additional weed infestation.

Many insects live in turf, but only a few are important enough to require control. Grubs and sod webworms may seriously damage lawns. Grubs are the larvae of June beetles or the Japanese beetle. Grubs eat the roots of grasses causing the turf to turn brown, to thin and die. Grub-infested turf will be loose and can easily be pulled back to expose insects. Sod webworm damage can be identified as areas of unevenly cropped grass. Large areas may turn brown, become thin and eventually die, exposing the lawn to weed invasion.

Sod webworms and grubs can be controlled with insecticides. Removal of grass clippings and thatch help reduce insect buildup.

STEP 6. Make Room for New Leaves

New leaves need room for growth. Many young, healthy leaves near the soil make a good lawn and reduce weed competition.

Thatch is an accumulation of dead leaves, stems and roots that form a tight organic layer over the soil surface. Thatch reduces water penetration, favors disease and reduces turf vigor, permitting weed invasion. Vigorous grasses, heavy fertilization and excess irrigation favor thatch accumulation. The problem is accentuated if clippings are not removed and turf is cut at 2 to 3 inches.

Improved mower catchers permit the

W. H. Dani
Crabgrass, well known to most homeowners, can be controlled in lawns with a pre-emergent herbicide, a chemical that kills the seeds before or as they germinate.

collection of clippings for off-site disposal. Power sweepers can be used occasionally to remove excess clippings.

About half of the nutrients used by the plant are present in clippings. More fertilizer usage is necessary to compensate for loss of nutrients when clippings are removed.

Earthworms eat dead plant material which can greatly reduce thatch. Lawns having ample earthworms need less dethatching or clipping removal. Repeated heavy insecticide use for grub and sod webworm control will also kill earthworms.

Bluegrasses, bentgrasses and other cool season grasses should be dethatched in mid-fall. This reduces any creeping annual grass and broadleaf weed competition present and permits adequate regrowth of new leaves before winter.

STEP 7. Protect Against Diseases That Kill Leaves

Proper identification of lawn diseases i vital. Fungicide use for disease control i time consuming, expensive and involve considerable tedium in managemen Select the proper chemical for the diseas and apply before damage becomes severe Don't encourage lawn diseases by over watering, over-fertilizing or by mowin too short. Lawns thinned because of disease are often severely invaded by weeds

A more practical method of diseas control is the selection and planting o improved, disease-resistant strains of desired grasses.

These seven steps when properly followed serve as a major means of weed reduction. Chemical weed control should be considered as an alternative if weed become a major part of the lawn.

COOL-CLIMATE LAWNS AND WEED CONTROLS

R. P. Freeborg and W. H. Daniel

ONCE you know the weeds in your lawn, you can select the proper chemical for their control. The following control procedures for weeds in cool-climate lawns are discussed by weed types. Specific chemicals for specific weeds are listed at the end of each weed-type section.

Broadleaf Weed Control

1 Always use the lightest adequate herbicide rate. Do not over-use just because turf can tolerate higher amounts.

2 Weeds can be treated any time they are actively growing. Late spring is the poorest time to treat as this opens up the turf to crabgrass and new weeds. Weeds germinate in spring, summer and early fall. Selective kill in September and October will assure a clean lawn next spring. This also favors desired grasses filling in for maximum turf cover next year.

3 Weed killers are most effective if applied when temperatures are above 50 F and soil moisture is adequate for plant growth. Avoid windy or hot days which favor droplet drift and vapor movement. Ample leaf area for absorption, such as when mowing might be done, favors more plant uptake of the chemical. It may take two to four weeks for complete kill. Delay spraying of new lawns until they have been mowed twice, or after thirty days of growing to allow grass seedlings to become tolerant.

4 The application of liquids and wettable powders requires certain procedures. Standard treatment involves dilution with ample water to moisten the foliage (1 to 3 gallons for each 1,000 square feet). Apply sprays at low pressure (20-30 lbs. per square inch). Avoid excess pressure which causes fine droplets or mist. And avoid spraying herbicides onto shrubs, flowers or trees. Double coverage (overlap) will prevent skips.

Dry granular herbicides are available alone or mixed with fertilizers. These are applied with special spreaders and dual weed and feed programs can be done in one operation.

Rollers, wax bars, canes and aerosol cans offer special application techniques particularly for individual plant treatment.

5 Read the label. Each label will give the percentage of active ingredient, recommendation for rate of use, some application aids and required cautions and warnings. The suggested dilutions (example, 1 ounce in 2 gallons of water for each 1,000 square feet) are aids to get uniform coverage of all plants in the area being treated. Two or three chemicals are often formulated together to assure control of numerous kinds of weeds. Chemicals acting together permit a lower application rate. Weed control with half rates of combined chemicals may exceed that obtained with standard rates of each chemical alone.

As an example, one gallon of formulation to use on broadleaf, vining and woody weeds can include: 2.6 pounds of active 2,4-D; 1.3 pounds of active MCPP; and 0.3 pounds of active dicamba. This is sufficient for 3 acres. One pint will cover 16,000 square feet, and 1 ounce is adequate for 1,000 square feet.

A rate of 1 pound 2,4-D per acre will kill most newly germinated broadleaf tap-rooted weeds, including dandelion, plantain, bull thistle, shepherds-purse, yellow rocket and curled dock.

A rate of 1 pound active ingredient MCPP per acre is effective on several kinds of weeds, including clovers, chickweed, and oxeye daisy. MCPP augments 2,4-D very well, and is often blended with about equal parts of 2,4-D. Use ½ pound per acre of each MCPP and 2,4-D, when the chemicals are mixed.

George Taloumis

A notched hand-weeder is handy tool for lifting weeds, such as dandelions, from the home lawn, especially when lawn areas are of limited size.

Weeds controlled by MCPP: Clover (*Trifolium*, spp.); common chickweed (*Stellaria media*); mouse-ear chickweed (*Cerastium vulgatum*); oxeye daisy (*Chrysanthemum leucanthemum*).

A rate of ¼ pound or less of dicamba per acre controls knotweed, chickweed, wild onion, yarrow, red sorrel, speedwell, clover, ground-ivy and henbit. For homeowners' use, it is blended with 2,4-D in a ratio of 4 to 10 parts 2,4-D to 1 part dicamba.

CAUTION: Since shrub and tree roots can absorb dicamba and/or MCPP from the soil, minimize danger by avoiding application in root areas of susceptible plants.

Weeds controlled by Dicamba: knotweed (*Polygonum aviculare*); wild onion (*Allium canadense*); yarrow (*Achillea millefolium*); red sorrel (*Rumex acetosella*); speedwell (*Veronica spp.*); ground-ivy (*Glecoma hederacea*); henbit (*Lamium amplexicaule*).

Crabgrass and Other Annual Grass Control

Preventing the competition of annual grass weeds such as crabgrass in the desired grass can make a big difference in lawn quality. Selective preemergence and postemergence chemicals can easil[y] prevent competition for space.

Preemergence controls act on ne[w] seedlings. Selective toxic chemicals ki[ll] weed seeds when they start to germinat[e] and the first root emerges. Some chem-icals act on seedlings up to the three-lea[f] stage for two to three weeks after germi-nation.

Uniform application is essential t[o] avoid streaks and skips. It is importan[t] to have a toxic concentration of th[e] chemical at the soil surface where th[e] seed germinates.

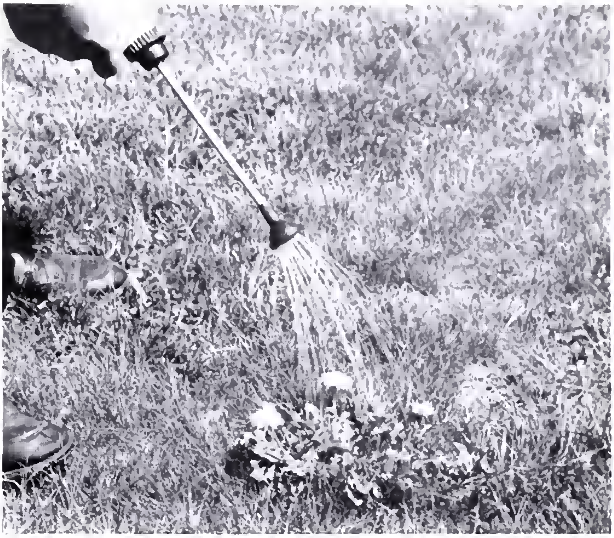
Soil warmth and ample moisture favo[r] germination of annual grasses.

Crabgrass control chemicals are in-cluded in the table below.

Generic	Trade	Active ingredien[t] per acre lb.	per 1,00[0] square fe[et] lb.
Benefin	Balan	2	.05
Bandane	—	40	1.0
Bensulide	Betasan	12	0.3
DCPA	Dacthal	12	0.3
Siduron	Tupersan	12	0.3

Siduron does not affect perennial gras[s] seedlings, so overseeding can be done any time if this chemical is used. Siduron us[e] allows selective start of desired grasse[s]

Most garden centers sell various kinds of prepackaged chemical weed killers, in their own dispensers and under different trade names, that are handy for spot removal of weeds. They save the homeowner the trouble of mixing his own herbicides, but label directions must still be heeded before use.



when spring seeding is needed.

Use of certain chemicals in August prevents fall germination of annual bluegrass. Siduron does not control annual bluegrass, but all other chemicals in the above table will.

Foxtail, sandbur, goosegrass, barnyardgrass, witchgrass, lovegrass and most other summer annual grasses are controlled by the products used for crabgrass control.

Mature, existing crabgrass can be killed with methyl arsonates. Two applications are necessary. They should be about five to seven days apart. Other annual grasses killed with this product include barnyardgrass, foxtail and dallisgrass.

Combining methyl arsonates with 2,4-D is practical for broader spectrum weed control. Goosegrass, witchgrass, sandbur and yellow nutsedge can be controlled with this combination.

Since preventing competition is vital, the use of preemergence herbicides has continued to be more widely used than postemergence treatments.

Creeping Weedy Grass Control

Creeping weedy grasses include bentgrass, bermudagrass, zoysia and quackgrass. In a good bluegrass lawn any unwanted plant is a weed. Variations in color, texture, rate of growth, or dormancy of bluegrass are signs that weed control is needed.

Choose from the following controls:

A. USE ITS GOOD FEATURES

1. *Bentgrass.* This grass can be managed as a suitable lawn grass in some areas. Bentgrass can be kept younger and healthier by repeated cultivating, aerating, thinning and raking.

2. *Bermudagrass and zoysia.* If a sprig is left it will spread again, so clean out all edges. Where wanted, plugs of the desired grass can be planted over the lawn area so it will spread out and cover bare areas.

B. HOT WATER KILL. Consider killing weeds by pouring at least ½ gallon boiling water per square foot on them. Vertically rake and chop into the area to assure better kill and a better seedbed before adding boiling water. Immediately cover the area after pouring the water with anything to help hold heat for a few minutes. Seeding can be done within an hour.

C. ENCOURAGE WINTERKILL OF BERMUDAGRASS AND ZOYSIA. Raking, close mowing, vertical thinning and/or slicing in late fall make plants more susceptible to winterkill. Fertilize with nitrogen four times the normal rate in September and again about October

Photographs by W. H. Daniel

Zoysia—a lawn grass that can also become a weed. It forms far-reaching, tough stolons that put down roots at every node, making eradication difficult.

1. The weed is then forced to grow and cannot build starch reserves before frost. Till and loosen repeatedly over winter. Timing is critical. This technique will not work in warm-winter climates. In late winter overseed, or over-sod in the spring.

D. FOLIAGE-KILLING CHEMICALS. Paraquat at 2 to 3 pounds active ingredient per acre has excellent leaf-killing power. It acts within twenty-four hours and permits reseeding in two to four days. It is possible to control bentgrass, nimblewill, annual bluegrass or other unwanted surface-growing grasses. Its use is restricted to commercial applicators by rulings in some states. Extreme caution in handling is needed.

Complete burns with solutions of ammonium sulfate, ammonium nitrate or other fertilizers dissolved in water are possible but seldom used. Hot, dry days, wetting agents, ample water, uniform coverage and completely wetting the foliage enhance results if these chemicals are used.

E. SYSTEMIC NON-SELECTIVE CONTROLS:

1. Amitrole, simazine, atrazine and other chemicals kill plants, but the grass discoloration and chemical residues last for weeks. These chemicals are not suggested for homeowners.

2. Dalapon at 4 to 10 pounds acid equivalent per acre can weaken and kill some grass plants. It moves within plants and works better if the area is cultivated after ten days. Repeat cultivation every seven to ten days as new growth first shows. Seeding should be delayed four to eight weeks because of chemical residues in the soil.

F. STERILANTS. Certain gases can be applied under plastic covering for sterilization. The treated area can be reseeded in two to four days after airing out. These are recommended only for use by experienced custom applicators. Do not use near trees and shrubs.

G. CONSIDER REMOVING SOD. Remove thatch and weeds and reseed with improved varieties. Bentgrass and nimblewill are easy to remove since they have only surface stems. Bermudagrass and zoysia have deep, coarse underground stems which must be completely killed. Till and pick out stems after cutting off sod.

Tall Fescue and Bunchgrass Control

Perhaps the lawn has a few clumps of unwanted bunch-type grasses. These will often reduce the uniformity and density desired.

Tall fescue is one of the most frequent contaminants in lawns. It is a clumpy, dark green, coarse-leaved, fast-growing perennial. It is most obvious in spring and fall. Tall fescue remains greener than bluegrass under drouth conditions.

Mechanical damage by severe chopping or vertical thinning with a power rake will weaken bunchgrasses. Frequent cutting of the lawn plus overseeding with desirable grasses will eventually eliminate bunchgrasses. A heavy infestation of bunchgrasses can be controlled with treatments discussed above in E, F and G.

A clump of tall fescue.

HOW TO CLEAN A SPRAYER

Equipment that has been used for applying herbicides should be reserved exclusively for that purpose. Even though a few herbicides can be washed out, most are difficult or impossible to remove completely, and minute amounts of residue may deform or otherwise damage sensitive plants. If a herbicide sprayer must be used for other purposes, thorough cleaning is imperative. Here are five ways to remove hormone-type herbicides.

1. Add ½ cup of household ammonia to 2 gallons of water. Discharge a little through the nozzle. Let the remainder stand overnight in the tank. After emptying it, rinse the tank, hose and nozzle thoroughly.

2. Add 1½ ounces of sal soda to 2 gallons of water. Let stand at least 2 hours, then discharge it through the nozzle. Rinse tank well, refill with water twice, discharging water also through the nozzle. This and the ammonia treatment (above) are for water-soluble formulations.

3. For oil-soluble compounds, add 1½ cups of kerosene and a little household detergent to the sal soda mixture, and proceed as described in method 2.

4. For either oil- or water-soluble formulations, add 10 ounces of lye to 2 gallons of water. Follow directions as for sal soda.

5. Add 1 ounce of powdered, activated charcoal and 1 ounce of household detergent to 2 gallons of water in the sprayer. Shake the sprayer for a minute or two, then discharge the solution through the nozzle.

Because even rinse water can damage plants it touches, it should always go down a drain. For similar reasons, empty herbicide containers should be disposed of with care. Thy should never be reused or burned, but they may with safety be buried in a plot that is free of garden plants.

A plan for encouraging attractive wild plants and decreasing lawn mowing

NATURALISTIC LANDSCAPING AND ENERGY CONSERVATION

William A. Niering and
Richard H. Goodwin

Wild or unused land in various stages of natural revegetation may possess great charm or may have tremendous aesthetic potential, if skillfully manipulated and maintained. Attractive native species of plants are usually growing spontaneously in such areas and only need encouragement through selective removal of the less desirable species that are crowding them. Here herbicides provide the owner with a technique for enhancing and maintaining the beauty of his property with a minimum of effort and expense.

This concept is especially relevant in an era when every effort should be made by the homeowner to decrease the size of his lawn since it is a high energy consuming landscape in terms of fossil fuel consumed, noise pollution, fertilizer required and pesticides used.

The Connecticut Arboretum (New London) has published a bulletin *Energy Conservation on the Homegrounds—The Role of Naturalistic Landscaping* which will highlight alternatives for lawns. If your lawn is too large, the concept of naturalistic landscaping should be seriously considered. It means allowing certain parts of the lawn to revert to a natural old field with hawkweeds, daisies, and lovely flowering grasses; introducing colorful species into the field and planting tree and shrub borders to decrease size of lawn. You will be following sound ecological land-use practices by the naturalistic approach since recycling and decreased fossil fuel requirements will be part of the plan.

In order to get the most out of a natural tract of land one should first take an inventory of the native species that are already present, their location, condition and potential size. Some may already be fine specimens and well placed, some may only be seedlings, and still others may be malformed or diseased. With this

(Text continued on page 28)

The sumacs, meadow grasses and other existing plants that make up this naturalistic landscape are pleasant to look at and much easier to maintain than a lawn or formal garden planting.
George Taloumis

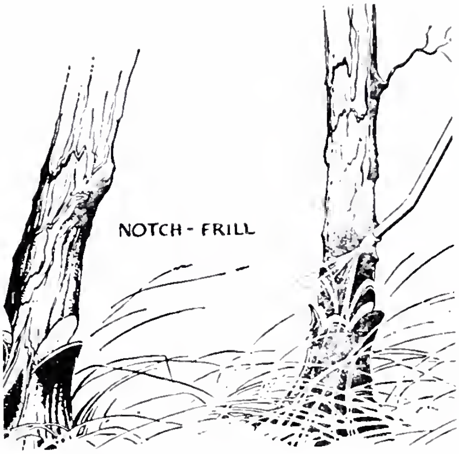
Photographs from the authors

1 The sloping thicket selected for naturalistic landscaping on the Matthies Tract of the Connecticut Arboretum in New London. Sumac and wild black cherry with mixed grasses dominate the foreground. Notice the red-cedar and gray birch, two common native trees with excellent characteristics for naturalistic landscaping projects.

2 The naturalistically landscaped demonstration area five years later. The more attractive columnar red-cedar and gray birch are now the accents in a relatively open matrix of grasses and scattered shrubs. The two white pines (in the foreground), which had been added, were subsequently removed.

3 The same demonstration area ten years later. Selective removal of less desirable plant material has continued. A flowering dogwood is now an important accent, especially when in flower. In the autumn, its red foliage is a highlight in the landscape, and in winter months, its branch habit is of interest. A highbush blueberry in flower is the lighter shrub in front of the red-cedar. Little bluestem grasses dominate the foreground.

4 The demonstration area after nearly fifteen years of management. The aspect is still relatively open. The increased and desirable development of the red-cedar and gray birch is clearly visible. Grasses and goldenrod are in the foreground, low huckleberry and highbush blueberry beyond the red-cedars and birches. At the present time the area appears much the same and requires very little maintenance.



In the notch and frill treatments, tree trunks are notched with an axe (as at left) or frilled with shallower cuts (right), and the exposed wood is soaked with the herbicide according to directions.

information in mind, plan the type of effect you wish to achieve—an open meadow dotted with specimen trees and shrubs, a screen from the highway or neighbor's yard, a shrub border at the edge of a woodland, swamp or pond. There are as many possibilities as there are tracts to be landscaped. Often enough attractive and interesting species will already be present, but if not, more can be planted. Native species are ideally suited to the climate and require minimum care.

Wherever weedy or otherwise undesirable trees, shrubs or vines are present, these plants may be selectively eliminated by appropriate treatments, *e.g.*, trees can be cut down, and the stumps treated with an herbicide to prevent resprouting *(stump treatment)*. Or, if desired, trees can be notched or frilled at the base with an axe and the notches or frills treated *(notch/frill treatment)*. In this case the tree will die standing and can be removed later or allowed to rot and fall, depending upon the circumstances. Shrubs, too, can be cut and stump-treated or the herbicide applied directly to the bases of the stems *(basal treatment)*. Vines, briers and brambles may also be selectively eliminated with the use of chemicals. Details concerning the types of herbicides and methods of application are discussed in detail in this bulletin.

Whenever it is practical, pulling young plants or seedlings by hand is to be preferred to the chemical approach. Non-sprouting species, such as the majority of the conifers, will obviously not require a chemical application.

If care is exercised, it is possible to eliminate the undesired species with almost no damage to adjacent vegetation. Thus, crowded specimens may be released, vistas opened up, and handsome plants made focal points or given the optimal surroundings for effective display.

The natural vegetation can also be manipulated by weed-killers in order to create or maintain various types of wildlife habitat. Different environments, such as dry fields, wet meadows, semi-open fields and thickets, support distinctive types of wildlife.

A grassland can be maintained by occasional mowing, by selectively spraying the woody species with herbicides as they appear, or by a combination of these methods. To maintain a thicket, trees, which would eventually shade out the shrubs, must be removed by basal, notch/frill, or stump techniques.

In the small woodlot or forest plantation, chemicals are useful in eliminating undesired competitive species. They can be used to good advantage in thinning an over-stocked stand where stem density is too great to permit successful development of individual trees. In Christmas-tree or other plantations, competing hardwoods can be readily removed with herbicides.

Naturalistically landscaped areas created within the Connecticut Arboretum two decades ago are showing the most remarkable stability. Once created, they require minimum maintenance. Part of the reason is that the shrub cover favored tends to arrest the establishment of tree seedlings. Although 2,4,D and 2,4,5-T have been used in creating these areas, the homeowner may wish to use AMS or a non-chemical technique—girdling—the simple removal of a band of bark from the tree some distance above the ground.

One of the best controls

MULCHES CAN CONTROL WEEDS

Leon C. Snyder

A MULCH is a protective substance such as compost or sawdust covering the soil. Mulches serve a variety of purposes in the garden including weed control. Other beneficial effects of a summer mulch are: moisture conservation, the lowering of soil temperatures (but black plastic raises soil temperatures) and a reduction in plant diseases. Mulches also aid in keeping vegetables and fruits clean. You can harvest your garden after a rain without getting muddy yourself or having to handle muddy crops if a mulch is present.

Plastic and paper mulches that come in rolls are commonly used in growing vegetables and strawberries. Nearly any organic material can be used as a loose mulch. The important considerations before choosing a mulch are: availability, cost and appearance. Partially decomposed compost makes an excellent mulch, especially if it is shredded. Sawdust, peat moss, shredded bark and wood chips are often used. Grass clippings can be used. Partially decayed hay and straw make excellent mulches except for their appearance. The appearance is improved by putting these through a shredder. Ground corncobs are useful where available. A saprophytic mold may develop on the corncobs in wet weather. Less commonly used materials include buckwheat hulls, coconut hulls and coffee grounds. Recently, several state highway departments have been using a layer of insulation material held together by a paper cover around newly planted trees.

Organic mulches should be applied in the spring after the soil warms and the crop is established. The area should be

Leon C. Snyder

Mulches not only suppress weeds. Many are attractive and serve a dual purpose by highlighting the plants they surround. Here a wood chips mulch sets off a grouping of dwarf evergreens. A disadvantage to mulches is that they can create a haven for mice.

Onions and beets are mulched with straw in a home vegetable garden.

Raspberries mulched with straw. Mulche are important for winter protection, too.

George Taloumis

A shrub border being mulched with shredded bark. Several kinds are available.

Peanut shells around fritillaria plants. Mos regions offer some organic mulch that i readily available and not very expensiv

A mulched area around trees will protect the trunks during mowing operations.

essentially weed-free when the mulch is applied. A thick mulch will smother small annual weeds by excluding light.

The plastic and paper mulches are often used in northern gardens to lengthen the growing season. Plastic has the effect of warming the soil, thus speeding germination and early root development.

Black plastic is superior to clear plastic for weed control. Many annual weeds such as purslane thrive under clear plastic. You should apply a preemergence weed killer if clear plastic is used. Plastic is laid down between rows after or during seeding for seeded crops. The plastic is laid down first for transplants. Insert the transplants through holes cut in the plastic.

Plastic mulches work best on row crops. They are difficult to cut and fit around shrubbery and plants in a flower border. When rock or stone mulches are used around evergreens and deciduous shrubs, lay down a plastic sheet first and cover with small stones or gravel. The plastic prevents weeds from growing up through the stones.

Organic mulches should be applied in the proper quantities. Depth of the mulch varies with the material used. It should be thick enough to smother weeds but not thick enough to prevent moisture from reaching the soil. Mulch reduces surface drying of the soil, but it should not be so thick that it absorbs all of the moisture from rains. A mulch 2 to 4 inches thick is sufficient for most materials.

Newly planted trees are often mulched for a few years to reduce the competition from surrounding grass and to keep lawn mowers at a safe distance. Trees should be protected by a cylinder of hardware cloth pushed into the soil to keep mice away from the base of the tree. Roses and clematis also benefit from a summer mulch.

Don't expect the mulch to choke out quackgrass or perennial weeds such as thistles and milkweed. Quackgrass thrives in an organic mulch and the new shoots will push up through deep layers of the mulch.

One application of mulch per season is sufficient for annual flowers and vegetables. At the end of the growing season organic mulches can be worked into the soil to add valuable organic material.

Plastic mulches should be removed from the garden in the fall since they do not readily disintegrate. Mulch around trees and shrubs does not need to be removed. A fresh layer should be added as needed to maintain the proper depth for weed control.

Soil organisms that bring about the decomposition of mulch may take nitrogen from the soil. This may cause a yellowing of the foliage on the plants. Add nitrogen at a rate of about one pound of actual nitrogen per 1,000 square feet of surface area to correct this deficiency.

Mulches are especially important in growing ericaceous plants such as azaleas and blueberries. Cultivation for weed control kills many shallow roots on these plants. Organic mulches aid not only in weed control but also in moisture conservation and in keeping the soil cool. The mulch also aids in the development of root mycorhiza that substitute for normal root hairs on these plants.

Fill your garden with fragrant plants to make hand weeding a pleasant pastime

WEEDS IN ORNAMENTALS

Jane P. McKinnon

Q. We have our first house and new plantings of trees, shrubs, a few perennials and a lot of petunias and marigolds. We don't want to spend all our time pulling weeds. What is the easiest way to keep our flower beds and shrub borders clean?
A. Welcome to a new world! You will find that hoeing weeds away from mock-oranges in bloom, or from clumps of fragrant clove pink or an edging of sweet-alyssum is not the worst chore of the summer! A sharp hoe to cut off young weeds at the soil surface early in their season and a 2- or 3-inch mulch of group-up or decayed leaves or locally abundant organic matter are good weed controls. There is no miracle product in a herbicide to be spread over everything before Memorial Day to keep weeds out until Thanksgiving. (See answers to following questions.)

Q. I grow gladiolus and dahlias in rows at the far end of my vegetable garden. Is there a weed killer that will be safe for both plants? Many of the weeds are wild grasses which have long underground runners.
A. Wild grasses with long underground runners are probably perennials, and quackgrass is one of the worst. Perennial grasses must be removed from garden soils before plants are established, because the safest and most useful chemical to kill grassy weeds will also kill garden plants. Use dalapon in the fall while grasses are actively growing; this will help to clear the area for the following spring. DCPA may then be used after planting divisions, corms or tubers. A DCPA treatment will control many annual weeds most of the summer.

Q. Is there a weed killer I can apply in my rose garden that would last all season? I sometimes use annuals (sweet-alyssum, ageratum, etc.) as a border around the rose beds. Could I plant them after using the weed killer?
A. Rose beds may be treated with trifluralin. This chemical kills germinating seeds. It must be applied to weed-free soil and worked into the top inch after the roses are established. Trifluralin is also labeled for use after transplanting ageratum and sweet-alyssum—just wait a few days to let the plants get started. Read the label carefully and use the amount recommended. However, if you have a long season, weeds may begin to germinate in three to four months after treatment. Since roses grow best under a mulch, it should not be necessary to repeat a chemical control. Simply mulch the bed after applying the trifluralin.

Q. When we visit my uncle's farm, we see acres and acres of corn without a weed, all done with a spray from the tractor. Can't we use the same product?
A. Probably not! The secret to chemical weed control in home gardens is using the correct material for the weeds present or expected, and then applying it to a plant for which tests have been made and recommendations approved. Weed killers safe to use on peonies may ruin pansies. Even for ornamental plants, there is no way to skip *reading the label!* Your own safety, the survival of your landscape plantings and the wise use of your garden budget are all good reasons to select the correct chemical for your purpose.

Q. My perennial garden is choked with chickweed. I pull the plants out but soon more appear, especially in the spring. There are also crabgrass and many other weeds I don't know the names of.
A. Chickweed may be the most frustrating pest weed you have, particularly if

Marjorie J. Dietz

One way home gardeners can reduce the weed population among flower borders, such as in this grouping of zinnias, is to "crowd" the plants. Though some hand weeding may be required while the plants are still in the seedling stage, they soon grow together, leaving no space for weeds.

George Taloumis
Lantana plants are mulched with pine bark. An edging of bricks is used to prevent the pine bark from being washed onto the adjoining walk—a problem with some mulches.

you have a very fertile, loamy soil. And the control of crabgrass is no easy task, either. Fortunately, DCPA, a preemergence herbicide, may be used for many weed seeds early in the spring after you have cultivated your garden and removed all the weeds you see. DCPA can be applied as a liquid spray or as granules, or it may be sprinkled into rock or organic mulches after they are laid. *Check the label* to be sure that your collection of perennials is listed among the plants tolerant of this material. Phlox, sweet William and carnations, for example, should *not* be treated with DCPA.

Q. Is there an all-purpose chemical weed killer to use in a perennial border? The plants are very close together and include day-lilies, summer phlox, nepeta, globe-thistle, bearded iris and Siberian iris.

A. The best all-purpose weed control in a border such as yours is a mulch. You could perhaps group the plants known to be damaged by DCPA in part of the border and avoid treating this area, but this would involve changing the design of your garden.

Q. Which weed killer would I use along my privet hedge?

A. Trifluralin may be worked into the soil around the hedge after the strip is cleared of weeds. This chemical will kill many weed seeds all season but some annual weeds are resistant. It has no effect, however, on established plants such as ground-ivy, quackgrass or creeping bellflower. Perennial weeds infesting a hedgerow will have to be hoed or pulled out.

Q. I am trying to establish two separate ground cover plantings. One is of pachysandra and the other of vinca (Vinca minor). What weed killer can I use in the plantings to get rid of the existing weeds

and keep them from returning?

A. I do not know of any chemical weed killer to be applied to established beds of ground covers. However, you may work trifluralin into the top 2 to 3 inches of soil before planting, and stop many annual weeds from appearing. Ground covers should be planted in well-prepared beds containing peat moss or other weed-free organic matter. Most successful ground cover plantings require some hand weeding before they become so tight with their own foliage that weed growth is excluded.

Q. About half of my garden property is shaded by tall trees and I am trying to establish a wildflower garden there. So far I have planted Christmas ferns, Jack-in-the-pulpit, some trilliums and wild orchids. Is there a weed killer I could use to kill undergrowth (catbrier, wild blackberry, Virginia creeper, etc.) near these plants, or must I continue to grub this unwanted growth out by hand?

A. You can experiment with AMS, applied with a paint brush to freshly cut stems of such woody growth. Treat a few plants at a time as far away from the wild flowers as possible. AMS travels through the root system and may kill the brush with one application. AMS in solution could also be poured from a sprinkling can over unwanted foliage, if it were completely away from clumps of wild flowers.

Q. I have set out a number of different shrubs in a long border. I have spaced the shrubs fairly far apart because most of them are only 2-4 feet high, but the weeds are getting ahead of me. The shrubs are mostly deciduous, but include a few rhododendrons and evergreen azaleas. Is there a safe weed killer to apply? How close to the shrubs can I use it?

A. When you read the label on the can, you will see that azaleas, rhododendrons and many other woody shrubs may be grown in soil treated with trifluralin. First, cultivate to remove all weed growth, then work the chemical into the top 2 to 3 inches of soil. Water it in when you finish. (*But check the list of shrubs cleared for trifluralin unless you want to conduct your own experiment!*) Follow directions carefully. Mulching with wood chips is an easy way to keep shrub borders weed-free in long growing seasons.

A planting of strawberries serves as an edging to a rose garden mulched with sugar cane.

Time-honored methods are the best here

VEGETABLE GARDENS WITHOUT WEEDS

Larry K. Binning

IT IS MORE practical to consider cultural practices for weed control than to use chemicals in the vegetable garden. Cultivation, hoeing, handweeding and mulching provide adequate control of most weeds in a garden and eliminate the possibility of herbicide injury to any garden crops. Gardens can be maintained with a minimum amount of labor when good soil preparation and proper planting are practiced so that cultivation and hoeing can be done with ease.

It is necessary to hoe and cultivate the garden area repeatedly because weeds germinate and grow throughout the season. Weeds should be hoed or cultivated at very young stages since damage from weed competition increases as weeds become larger and removal of large weeds may damage the garden crops. Cultivate shallowly because deep cultivation injures the root system of the desirable garden plants. Hoe and cultivate no deeper than necessary to break the crust on the soil and remove weeds. Hand pulling of weeds in the vegetable rows should also be done when weeds are small. Once the weeds have developed a large root system, pulling the large weed may damage the vegetable plant roots and severely injure them.

Mulching

Mulching garden areas effectively controls weeds. Mulching also conserves soil moisture and prevents crusting of the soil. Organic mulches, such as hay and straw, keep soil temperatures cool and provide a protective layer that keeps vegetable crops clean and off the soil surface. However, mulches provide a good environment for such pests as mice and snails. When an organic mulch is used, it should be applied in sufficient depth (6 inches) to keep light from reaching weed seedlings. Common organic mulches include straw, wood chips, sawdust, leaves and other plant by-products.

Black plastic film may be used as a mulch and may accomplish many of the results of organic mulches. Plastic mulch is not bulky and is relatively easy to handle. Black or opaque sheets of plastic prevents light penetration, thus giving excellent weed control. Roll on the plastic and secure it by burying the edges with soil.

Because the plastic is not biologically decomposed at the end of the season, it should be removed from the garden area before spading or plowing. It is important that black plastic or opaque be used. Because light penetrates the clear types of polyethylene plastic, a heavy weed infestation will grow beneath them.

Herbicides are widely used in commercial vegetable crop production where large acreages are grown to a single crop. But in home gardens where several different vegetables are grown within a small area and, since no single herbicide is usually suitable for all of the crops, it is more difficult to use herbicides. Because a herbicide may cause injury to some vegetables, may leave residues in the soil that will affect crops the next year, or may not be cleared for use by the Environmental Protection Agency, it is essential that information on labels be followed and that the herbicides be used properly.

Several herbicides are available for use under a variety of trade names. The common name of the herbicide or the chemical is printed somewhere on the label. Herbicides labeled for garden use are listed in the following table; both the common and chemical names

Use a rototiller to cultivate the vegetable garden's soil in spring before setting out seedlings or sowing seeds. This will remove early-germinating weed seeds. Then continue to remove weeds as the season advances by hand-pulling or hoeing.

George Taloumis

are included. None of the herbicides listed will control established perennial weeds. These must be controlled prior to planting the garden or must be controlled by mechanical means or mulching.

Table of Herbicide Names

Trade Name	*Common Name*	
Dacthal	DCPA	Dimethyl 2,2, 5,6-tetra chloro= terephthalate
Dymid Enide	diphenamid	N,N-dimethyl-2,2-diphenyl= acetamide
Vegiben, Amiben (Weedone garden weeder)	chloramben	3-amino-2,5-dichloroben= zoic acid
Treflan Preen	trifluralin	2,2,2-trifluro-6-dinitro-N,N-dipropyl-p-toluidine

When choosing a herbicide, read and follow all label directions. Directions differ from one product to another as to amounts to use per area and the method of application.

DCPA is a preemergence herbicide applied to soil before weed seeds germinate or emerge from the soil. DCPA can be used on a large number of vegetables and flowers. Read the label to determine which crops may be treated successfully. It controls annual grassy weeds better than annual broadleaf weeds and, in fact, some annual broadleaf weeds are totally resistant and will require mechanical removal for satisfactory weed control. DCPA should be watered in within one to three days after application if rain does not occur. DCPA is generally applied after seeding or after transplanting of the garden crops but before weeds appear. In some instances it may be desirable to allow the vegetable seedlings to become established, then remove the weed seedlings and apply DCPA to provide continued control.

Diphenamid is another herbicide that can be used on a number of vegetables. Diphenamid is a preemergence herbicide and must be used prior to weed emergence. Diphenamid, like DCPA, should be watered in within one-three days after application to provide the best control. A list of tolerant vegetables and flowers and the weeds controlled is found on the product label. All label instructions should be carefully followed. Diphenamid is available in various concentrations and forms, and the application rate will vary according to product formulation.

Trifluralin is a herbicide which must be mixed into the soil before planting to provide the best control. Preplanting incorporation means that the product is mixed into the upper 1-3-inch layer of soil prior to seeding or transplanting garden vegetables or flowers listed on the label. When it is not practical to incorporate trifluralin into the soil prior to planting, the herbicide may be applied after planting and then watered into the top layer of soil. The amount of the herbicide to use is determined by the suggested rates listed on the label and the method of application. Rates vary with soil types. The label contains a list of crops on which the material may be used and a list of weeds that it will control. Label recommendations must be followed carefully.

Chloramben may be used on a wide variety of vegetables and ornamentals to effectively control many broadleaf and grassy weeds. Chloramben is a preemergence herbicide which is applied to soil after planting and prior to weed emergence. Chloramben should also be watered into the soil within one-three days after application to provide best control. The application rate will depend on the formulation of the material, and the label should be consulted and followed carefully to insure proper rates. A list of tolerant ornamental and vegetable crops appears on the product label, and it is important to apply chloramben on only those crops listed. Follow other label suggestions in order to insure desirable weed control without crop injury.

There are a number of other herbicides available for weed control in vegetables, but they tend to be very specific as to crops and/or weed problems. For information on specific weed problems or herbicides for specific purposes, it is necessary to consult a knowledgeable source in the area.

Molly Adams

Black plastic is a recommended mulch for vegetable gardens. Sections of the plastic have been cut to fit these board-enclosed beds. Slits are then made in the plastic in which to set out plants or sow seeds.

Fig. 1 Comparative growth of cherry trees five years after planting. Weeds were controlled under the trees with herbicides (right). Weeds were not removed from trees (left).

Eliminating weeds from under fruit trees will improve the harvest

WEED CONTROL UNDER FRUIT TREES

A. R. Putnam

FRUIT farmers have long recognized the need for controlling weeds in their orchards and groves. To the homeowner, weeds under their fruit trees are unsightly and require repeated hand trimming or weeding in the areas the mower cannot reach. Weeds compete directly with trees for soil moisture and nutrients and often serve as hosts for insects, nematodes, and diseases which attack trees.

Weeds may also provide cover for rodents which attack fruit tree trunks during the winter months. Certain noxious weeds, such as poison-ivy or Canada thistle, may make harvesting of fruit an unpleasant task.

To produce a healthy tree with a strong trunk and scaffold branches, it is necessary to provide optimum growing conditions in the first few seasons. Perennial weeds such as quackgrass, johnsongrass, or Canada thistle can seriously reduce the growth of newly planted trees. These weeds should be controlled with repeated tillage or herbicides prior to planting a new orchard.

Annual weeds may also inhibit the growth of young trees, particularly stone fruits (Figure 1). Annual weeds should be controlled when the trees are actively growing. Control of weeds in an area 2 to 3 feet from the trunk is adequate the first two years. As the tree becomes bigger and the roots spread over larger areas, weeds should be controlled on an area about equal to the foliage area of the trees.

There are numerous approaches to control weeds under fruit trees. The method you choose depends upon the number of trees involved and the expenditure you are willing to make for equipment, materials and labor.

Cultivation. Deciduous and citrus fruit crops have been grown under a clean cultivation system of culture in several areas of the United States. This requires repeated tillage with power equipment to continually destroy emerged weeds. Hand cultivation three or four times a season may be satisfactory for controlling weeds around a small number of trees in the home garden. When hoeing or cultivating around trees be careful not to cut too deeply and injure tree roots.

It is difficult to use power cultivators like rotary tillers without injuring the tree trunks or roots. Wounds caused by tillage equipment are easily invaded by disease-producing organisms. Cultivation is more difficult to accomplish on sloping areas and may cause soil erosion problems. Each cultivation will assure you of a new crop of weeds, since the seed is brought near the surface where conditions are favorable for germination. Cultivation has become less popular with commercial fruit growers since the development of good selective herbicides for orchard use.

Mulching. An alternative to cultivation around young trees is the use of a mulch, such as straw, wood chips, peat moss, sawdust or other vegetable matter (Figure 2). Mulching is particularly applicable when only a few trees are involved. In order to prevent the growth of annual weeds, mulches must be applied at least 3 or 4 inches deep. Mulches will not effectively control perennial weeds. During the first two seasons, mulch should be applied on areas 3 to 4 feet in diameter around the tree. Larger areas may be mulched as the trees get larger.

Organic mulches decompose and eventually release nutrients useful for tree growth. Initially you should use slightly more fertilizer to aid the decomposition process. Mulches allow excellent penetration of rainfall and conserve soil moisture. Roots tend to develop abundantly near the surface of the soil under mulch. This does not mean that the tree as a

Photographs from Michigan State University Photo Lab

Fig. 2 A mulch such as wood chips can provide effective weed control under trees and at the same time be attractive in appearance. A mulch also eliminates mowing near trunk.

Fig. 3 Granular dichlobenil that was applie in November on this 8 by 8-foot area ha given excellent control of annual and per ennial weeds.

whole is more shallow-rooted. Mulching is probably the best method of weed control for trees located on steep slopes where cultivation is difficult and erosion is likely to occur.

Attention must be given to rodent control where organic mulches are used. Field mice and meadow and pine voles can seriously girdle the trunks and roots of trees during the winter months. Mulches can be removed in early fall from an area about 1½ feet from the trunk on trees susceptible to this problem. Wire or plastic trunk guards are often utilized to prevent rodent damage. Mulch or other decaying vegetation is thought to aggravate the foot-rot problem in citrus. You should provide good air movement near the base of these trees.

The best mulch to use is often determined by its availability and cost. Hay and grass clippings are not as satisfactory as other organic materials because they contain many weed seeds. Plastic or paper sheets, crushed stone, or combinations thereof have been utilized effectively as mulching materials under trees.

Mowing. Mowing is a popular method of reducing weed competition in orchards. Mowing is particularly useful for the home gardener. The areas between trees can be maintained as short turf giving a neat and clean appearance. The use of mulches or herbicides on the area under the tree eliminates the need to mow these areas. Homeowners with limited space and only a few fruit trees may find this method most satisfactory.

Herbicides. Several herbicides are utilized effectively by commercial fruit growers. They provide economic advantages over cultural methods. Fruit trees are not completely immune to herbicide injury but will often tolerate dosages much higher than required to kill weeds. Trees gain herbicide tolerance with age. Newly planted trees may be susceptible to herbicide injury, gain some tolerance when two or three years old, and become very tolerant when older. Trees growing

TABLE 1. Granular preemergence herbicides suitable for the homeowner with a few fruit trees.

Herbicide	Ounces of formulated[1] chemical per 1,000 square feet	Crops[2]	Time of application and other comments
dichlobenil (CASORON 4% Granules)	36 to 55	Apples, Avocados, Cherries, Citrus[3] Fruits, Figs, Mangoes, Nectarines, Peaches, Pears, Plums, Prunes	Apply prior to emergence of annual or perennial weeds. Use the highest rate of application for perennial weeds. Do not apply until one month after planting new trees. For best results, either water lightly after application, mix evenly into the top 1-2 inches of soil, or cover with about 2 inches of mulch.
trifluralin (TREFLAN 5% Granules)	7 to 14	Apricots, Cherries, Citrus Fruits, Peaches, Plums, Prunes	Apply prior to emergence of weeds. For best results, either water lightly after application, mix into the top 1-2 inches of soil, or cover with about 2 inches of mulch.

[1] The lowest rate should be used on sandy soils that are low in organic matter.
[2] Uses on these crops are registered with the Environmental Protection Agency effective June 1, 1973, and are subject to change.
[3] Includes grapefruit, lemon, orange and tangerine trees.

on sandy soils which are low in organic matter are more susceptible to preemergence herbicides than trees growing on heavier loam soils. Herbicides must be applied as accurately as possible to minimize the possibility of tree injury.

Many herbicides used by commercial fruit growers are not practical for the backyard gardener because of special equipment needed for their application and because they are not readily available in small package quantities.

There are instances when certain herbicides can be used to save considerable maintenance under trees. When only a few trees are involved, granular formulations containing a low percentage of active ingredient can be used effectively. Before application, you must decide what area to treat and calculate the proper amount of material for that area. The required amount for a specific area of soil should be sprinkled uniformly over the surface prior to weed emergence (Table 1). A light watering or raking of the chemical into the top inch of soil often increases its effectiveness.

Chemicals are usually applied in early spring or fall prior to the time most weeds emerge. Applications made in circular or square patterns around trees can effectively suppress weed growth for the entire growing season in temperate climates (Figure 3). Herbicides should not be used where soil is likely to wash (sloping sites) with heavy rains. Herbicide wash can damage adjoining turf or ornamentals.

In more extensive fruit plantings, herbicides may be applied with suitable knapsack sprayers or granular spreaders (Table 2). The equipment must be calibrated (see page 45) carefully at a comfortable walking speed prior to applying

TABLE 2. Herbicides suggested for use in larger home orchards when suitable application equipment is available.

Herbicide	Pounds of active[1] ingredient per acre	Crops[2]	Weeds controlled	Time of application and other comments
2,4-D (acid or oil soluble amine)	1	Apples, Pears	Emerged broadleaved annuals and perennials	Apply as a directed spray under trees and in sod areas between trees. Do not allow drift to touch the foliage of trees.
dalapon	3 to 7.4	Apples, Apricots, Citrus Fruits,[3] Peaches, Pears, Plums	Annual and perennial grasses	Apply as a directed spray under trees before grass is 10 inches tall. Do not allow spray to touch foliage of trees. Do not apply within 30 days of harvest. Check label for maximum use rate on each fruit crop.
dichlobenil	4 to 6	Apples, Avocados, Cherries, Citrus Fruits, Figs, Mangoes, Nectarines, Peaches, Pears, Plums, Prunes		Apply to orchard floor prior to emergence of annual or perennial weeds. Use the highest rate of application and granular formulation for perennials. Do not apply until one month after planting new trees.
Herbicidal oil	60 to 100 gallons	Apricots, Avocados, Citrus Fruits, Dates, Olives, Papaya, Peaches, Pears, Plums, Prunes	Emerged annual weeds	Apply as a directed spray under trees when weeds are small. Larger weeds require the higher rate. Very flammable, keep away from sparks or cigarettes.
simazine	2 to 4	Apples, Avocados, Cherries, Citrus Fruits, Olives, Peaches, Pears, Plums, Prunes	Germinating annual weeds	Apply only to trees established one or more years. Apply before weeds emerge. Do not apply to foliage or fruit.

[1] Rates are amounts of chemical per acre sprayed. One treated acre may be 3 or 4 acres of orchard, since only bands are sprayed.
[2] Uses on these crops are registered with the Environmental Protection Agency effective June 1, 1973, and are subject to change.
[3] Includes grapefruit, lemon, orange and tangerine trees.

Fig. 4 This pear orchard was treated with simazine at 4 pounds per acre. The chemical was applied in a band along the tree row.

chemicals in the orchard. Overapplication can result in serious tree injury or even death of trees. Accurate application is best accomplished by treating a band of the desired width along each side of the tree row (Figure 4).

Unique weed problems may develop that require a specific herbicide for effective control in different geographical areas. Consult local Cooperative Extension Service personnel for advice on these specific problems.

WHY AND HOW TO CALIBRATE EQUIPMENT

Why is calibration so important when using weedkillers? Because recommended rates are based on applying a given amount of *chemical* (not solution) to a specified area.

With weedkillers, the amount of water or other carrier can vary widely without making a significant difference, but the amount of concentrate (the packaged product) must remain the same for the given area. In other words, the nozzle opening, pressure, speed of application and other factors may determine discharging one or 40 quarts of water over a 1,000-square-foot area. *The amount of product* to be added to the water *remains the same* in either case.

Careful measuring and uniform application are essential, too. This is because most herbicides are growth regulators, and are active in very small amounts, usually from 1 to 8 pounds per acre, rather than 1,000 to 2,000 pounds per acre as with fertilizers. If even a small error is made, it will be proportionately large and change the effect of the chemical.

It is a good idea to test your sprayer with plain water on a 10 x 10-foot area (100 square feet). This way you can find out how much your sprayer applies at a comfortable speed. Then you can figure how much and how strong a solution to make up for treating your lawn or other planting with your sprayer. Once the general rate of application has been established by calibrating, it can be used as a gauge for that particular piece of equipment, and the procedure need not be repeated unless one or more factors are changed.

Plan to apply the solution by criss-crossing, spraying first from end to end and then from side to side. This will assure even application.

Keeping the home berry patch free from weeds

SMALL FRUITS AND WEED CONTROL

Richard D. Ilnicki and John A. Meade

AS WITH most garden or vegetable crops, weeds can plague the home gardener who has small fruits such as strawberries, blueberries, or bramble fruits just as much as they do the commercial grower. Usually the annual weeds, including a wide variety of broadleaf and grassy weeds, are more common than perennial ones. Perennial weeds, however, if not checked early in their development, can cause trouble because by nature many of the small fruits are perennial plants, also.

Strawberries

The most practical way to control weeds in small home gardens is to hoe or hand-pull them. Pulling weeds or hoeing them from strawberry beds is a chore seldom relished by home gardeners but it is by far the safest method. However, many experienced gardeners use herbicides as the commercial growers do.

The question of which herbicide to use can itself be a problem but the grower, after a little experience, should be able to choose the right herbicide or combination of herbicides. The herbicide treatment selected should of course control weeds but not injure newly set-out plants or the runners they develop, not inhibit the rooting of runners and not leave any residue contaminating the fruit. Moreover, it should be safe for the gardener to handle.

Several herbicides meet these requirements. The most useful ones are DCPA, diphenamid, chloroxuron and dinoseb.

Proper application of these herbicides will eliminate the need for much mechanical cultivation or hoeing and hand-pulling. Some cultivation may be necessary, however, to remove weeds that are present prior to the application of the herbicide, to loosen the soil in order to enhance the activity of the herbicide and to hasten the rooting of runners. Cultivation is often necessary, too, to remove excessive runner growth in late summer.

Herbicides should be applied to established transplants rather than to newly set ones since the latter are usually under physiological stress. Wait two or more weeks before applying herbicides to transplants. Some directions for proper use of herbicides follow.

DCPA, sold commercially as Dacthal W-75, is practically non-toxic to humans or animals or to the strawberry plants. A 5 percent granular form is also available. It is not caustic or corrosive. After spray applications just rinse the spray equipment with clean water. There is no danger from drift or volatility from the ground after spraying. Furthermore, researchers have indicated there is no carryover in the soil. Because of this, an additional application may be made to control susceptible weeds in late summer.

DCPA must be applied before the weeds emerge and may be sprayed directly over new sets. It is effective on most annual grass and broadleaf weeds but is not effective on members of the Cruciferae (mustards and related weeds), and often misses common ragweed.

DCPA may be applied immediately after transplanting or to a weed-free soil after initial cultivation, usually 10 days to 2 weeks after transplanting. Irrigation following application will help to incorporate the herbicide into the upper layers of soil. While repeat applications may be made throughout the summer, control will usually last most of the growing season. The soil should not be disturbed unless weed growth makes it necessary. The few surviving weeds can be removed by hoeing rather than treating again with chemicals.

DCPA may be used in established strawberry plantings provided the bed is thin enough to permit the herbicide to reach the soil surface. It may also be applied after the removal of mulch in the spring but before the weeds emerge. *Application rate:*

For 1,000 square feet: Add 4½ ounces DCPA W-75 to 1 gallon of water or apply 4 lbs. of the 5 percent granular formulation evenly.

It is suggested that the commercially prepared herbicide be mixed in a separate container, using just enough water to thoroughly wet the product. Then add the slurry to the rest of the water in the spray tank. Adequate agitation is necessary to keep the wetable powder in suspension. If screens or strainers are used in the spray head, a 50-mesh or coarser screen usually works the best.

The initial growth of some strawberry varieties may be slightly affected by DCPA applications. The effect is short-lived and the initial slight stunting of growth is rapidly outgrown. Other varieties have not been affected by recommended rates of DCPA.

Diphenamid is available commercially under three trademark names: Enide 50W, Dymid 80W, and Dymid 5G. It may be safely used on most strawberry varieties, but several varieties may be temporarily affected initially. The early stunting is usually outgrown and normal growth resumes. This short-lived checking of growth may be avoided if applications of this herbicide are delayed until the transplants become established and show active growth. 'Sparkle,' 'Dixieland' and 'Sunrise' and possibly other popular varieties show no ill effects from diphenamid.

Diphenamid may be applied over the plants two to six weeks after setting but must be applied to a clean soil surface. A longer waiting period is suggested for those varieties that may be affected. Additional applications may be made at intervals of six months or more; however, diphenamid should not be applied within 60 days before harvest. Early spring applications can be made after mulch removal. Full-season control of all annual grasses may be achieved and most annual broadleaf weeds are controlled. Some plants of common lambsquarters may survive this treatment but these can be easily removed by hoeing or hand-pulling. *Application rate:*

For 1,000 square feet: use 1¾ ounces of the 80 percent formulation or 2¾ ounces of the 50 percent diphenamid in a gallon of water. Preparation of a slurry is suggested in the same manner as DCPA. Apply 1¾ pounds of the 5 percent granular formulation evenly over the 1,000 square feet.

Chloroxuron is sold either as Norex 50W or Tenoran 50W. It is a postemergence herbicide and can be applied in the spring and then again in the fall on established beds or in newly transplanted beds as soon as the sets are established. It is particularly effective on broadleaf weeds and young seedling grasses; however, the latter are difficult to control after they have more than two leaves or are more than a half-inch tall.

For best results, chloroxuron should be applied after renovation in late summer with a repeat application in the spring after mulch removal. No more than two applications in a year should be made and no applications should be made with 60 days of harvest. *Application rate:*

For 1,000 square feet: apply 3 ounces of the wettable powder in a gallon of water. To insure proper wetting of the formulation, a slurry should be prepared in the same manner as DCPA and diphenamid.

Dinoseb or DNBP—If good weed control practices have been carried out throughout the year and mulch was used in late fall or early winter, home gardeners will have little need for dinoseb.

Dinoseb is an aqueous solution containing 3 pounds of the active ingredient per gallon. It is poisonous, somewhat corrosive and stains yellow. Drift and volatility may injure ornamental plantings and mustard-type crops. Fruit trees in bloom may be seriously injured from spray drift and fruit-set seriously affected. There is, however, no contamination of the sprayer if properly mixed and no hazards from residue in the soil.

Should this herbicide be used, it is strongly recommended that dinoseb be applied on a sunny day with seasonably high temperatures in late fall *after the strawberry plants become dormant* and applications should be limited to the middles and shoulders of the beds. It is a contact-type chemical that is especially good for common chickweed, henbit weeds and mustard weeds. *Application rate:*

For 1,000 square feet: use 3 tablespoons in 2 quarts of water.

The herbicides discussed above when properly applied can produce more than adequate weed control in strawberries for the home gardener as well as for the commercial grower.

Blueberries

Cultural Methods

First and foremost comes the time-honored method of controlling weeds—pulling or hoeing or cultivation by hand. Only one precaution here: do not cultivate too deeply or too close to the plants. The feeder roots on blueberries are very near the surface and you may cut off a good many with too vigorous a cultivation.

Even with the use of herbicides, some hand weeding will be necessary to remove weeds which are resistant to herbicides.

Chemical Treatments

Cultivated blueberries grow under rather peculiar conditions and hence have peculiar weed problems. Blueberries require a soil high in sand but also high in organic matter. The soil must be acid, pH 4.0 to 5.0, and should have a high water table. These, of course, are the soils in which native azaleas and mountain-laurel as well as wild blueberries thrive. The recommendations below are developed for this type of soil. For soils other than these, consult your local agricultural authorities.

If you are tired of pulling crabgrass, pigweed, common lambsquarters and other weeds out of your blueberry plantation, here is what to use:

Diuron is available as Karmex 80W, an 80 percent wettable powder. Put 1 ounce in a gallon of water, shake well, and spray on 1,000 square feet of soil. Avoid applying the spray to the foliage.

Simazine is sold as Princep 80W. Put 2 ounces in 1 gallon of water, shake well and spray on 1,000 square feet of soil. Avoid applying the spray to the blueberry foliage. Simazine is also sold as a 4 percent granular material. Apply 2¼ pounds of the 4 percent granules to 1,000 square feet of loose soil.

Both of the above should be applied to weed-free soil in early spring prior to bloom. These herbicides will prevent new weed seeds from germinating but will not kill weeds already up. Use these herbicides only on bushes which have been in place more than one year.

Chlorpropham is sold as an emulsifiable concentrate liquid and as a 5 or 10 percent granular form.

Put 3 fluid ounces or 6 tablespoonsful of the emulsifiable concentrate liquid in 1 gallon of water and spray on 1,000 square feet of soil. Apply 1¾ pounds of the 5 percent or 14½ ounces of the 10 percent granular form to 1,000 square feet of loose soil.

This herbicide, applied to weed-free soil in the fall, will prevent germination of most winter annual weeds. It can also be applied in the spring to control such annual grasses as crabgrass, barnyardgrass and goosegrass. It is also effective against common chickweed and dodder.

All of these applications should be followed by ½ inch of irrigation to carry the herbicide into the soil where the weed seeds germinate. Do not cultivate the blueberries unless for some reason the herbicide fails and weeds come in.

The herbicides mentioned here are available from most farm or garden supply stores. Other materials are constantly being evaluated for effectiveness in blueberries but the ones listed have proved safest and most efficient. One final word of caution: Do not add "one more for the pot" with weed killers. If applied at too high a rate, blueberry injury can occur. Use the recommended amount and *read the label*.

Bramble Fruits

This group of delectable, fragile fruits includes blackberries, raspberries, loganberries, dewberries and boysenberries. There may be other localized varieties and names for members of this thorny, fast-growing group of plants of the rose family.

If left to grow unchecked, there would be no weed problems in brambles because they would soon shade out all the weeds. However, in order to obtain fruit production, the vines must be pruned vigorously and hence weeds can grow.

New Plantings

When setting out new plants, the soil should be in good tilth and all old plant growth should be removed. After setting the plants, the soil should be treated to prevent weed seeds from germinating. Use of the following:

Simazine is sold as Princep 80W, a wettable powder, and Princep 4G, a granular formulation. Apply 1 ounce of Princep 80W in about 1 gallon of water to 1,000 square feet. If you use the granular, apply 1 pound of the Princep 4G evenly to 1,000 square feet.

Diphenamid is sold as Dymid 80W, Dymid 5G and Enide 50W. To each 1,000 square feet apply 2 ounces of Dymid 80W or 3 ounces of Enide 50W or 2 pounds of Dymid 5G. Application should be made right after planting.

Established Plantings

The following herbicides are designed primarily for the control of germinating weed seeds. Hence the existing weed growth should be removed and the soil loosened. Then apply:

Simazine, sold as Princep 80W or 4G. Apply 2 ounces of Princep 80W in 1 gallon of water to 1,000 square feet or apply 2 pounds of Princep 4G evenly to 1,000 square feet.

Diuron is sold as Karmex 80W. Apply 1 ounce of Karmex 80W in 1 gallon of water to 1,000 square feet.

If rain does not fall within two or three days, a light sprinkling will increase control of the weeds. Do not apply these herbicides when fruit is present.

Some perennial weeds are resistant to herbicides. Such "escapes" should be removed by hoeing or pulling.

Grapes

With the increased interest in homemade wines and a corresponding increase in the number of vintners, it is expected that many small vineyards will become established. Weeds in grapes cause the same problems they do in other crops by competing for light, fertilizer, water and space. Heavy weed growth also causes troubles at harvest.

While cultivation and mowing should control most of the weeds, there are herbicides available for use in grapes, especially useful when the plantings are extensive.

Suggested applications per 1,000 square feet are:

For new plantings—Dichlobenil (Casoron) is sold as a 50 percent wettable powder or a 4 percent granular. Use 3 ounces of the 50 percent WP in 1 to 2 gallons of water or apply 2 1/3 pounds of the 4 percent granules evenly over the area. Do not apply within four weeks after transplanting. For best results, apply during the period November through March 15.

For plantings 3 years or more old—Simazine (Princep) can be used on weed-free soil before bud break. Apply 1 ounce of the Princep 80 WP in 1 to 2 gallons of water or apply 1 pound 2 ounces of the 4 percent granular Princep evenly over 1,000 square feet. Diuron (Karmex) can be used in the spring on weed-free soil as a band on either side of the row. Do not spray the middle areas between rows. Use 1 ounce of the Karmex 80 WP in 1 to 2 gallons of water to cover 1,000 square feet.

Diuron and simazine usually provide control of annual grasses and broadleaf weeds throughout the season. The rates listed are for sandy soils and can be increased according to label instructions for heavier soils.

Two scourges, mostly of the summer season

POISON-IVY AND RAGWEED

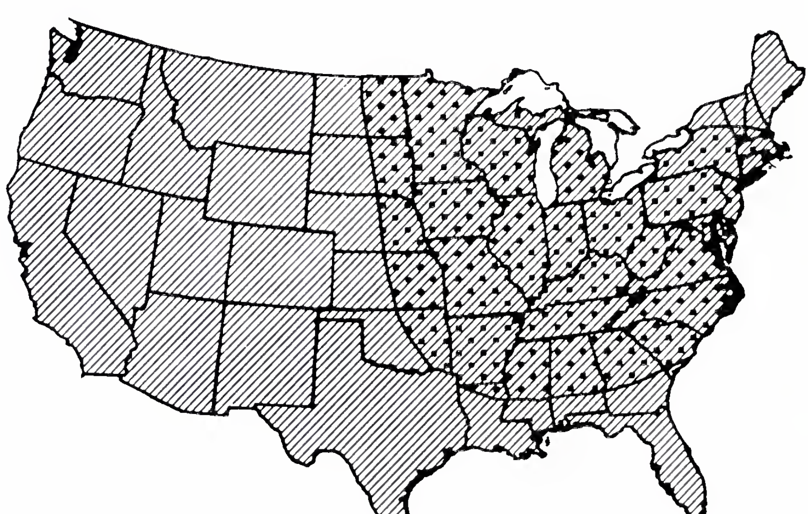
John A. Meade

"LEAVES of three—let it be" is an old saying designed to save people the agony associated with the symptoms of poison-ivy poisoning. This plant, one of our native American weeds, is widely distributed over a large part of the United States and is credited, along with mosquitoes, with slowing down colonization of North America.

The poison-ivy plant *(Rhus radicans)* is variable in many of its characteristics, but it always has three leaflets with the center leaflet on a petiole or stem. The leaf margins are often without indentations, but sometimes notches occur. The most common form is a vine found growing along hedges, stone walls, fences, trees and even in cultivated plantings where it is often mistaken for an ornamental vine. When growing in the open the plant will assume an upright form up to 36 inches high.

Authorities differ somewhat on names for various species but most people call the deeply lobed, upright shrub form, poison-oak. A distinctive type growing on the West Coast is called Pacific poison-oak. Whatever the name, they all have the three leaflet characteristic and each has similar white or cream-colored clusters of fruit. These are readily apparent in autumn when the leaves fall but are rapidly removed by birds (and thus transported elsewhere to start new plants). A related plant, poison sumac, *R. vernix*, also has the white fruits. Sumacs with red berries are considered non-poisonous.

The toxic compound, urishiol, is a non-volatile higher alcohol found in all parts of the plant. The danger of poisoning is highest in spring and summer but infection can occur even in winter if the bark



Map showing distribution of poison-ivy (*Rhus radicans*).

From Common Weeds of the United States

Poison-ivy *(Rhus radicans)*. A, habit; B, flower panicle; C, flowers; D, drupe; E, stones.

is broken. Some people claim that "poison-ivy jumps out and gets them" but this is untrue. There are, however, other ways to contract poison-ivy than by direct contact with the plant. The toxic material can be transferred by garden tools, pets, car-door handles and even golf clubs. The toxic material can be carried on ash particles of burning poison-ivy. The most agonizing cases are produced in this way since infection occurs in the eyes, ears, mouth, and other parts of the body. There is some question as to whether the pollen is toxic. Some people attempt to gain immunity by eating a few leaves in the spring but this concept is absolutely untrue. A person should never eat poison-ivy leaves.

The toxic material remains in the plant for some time so even dead material should be handled with care. The best way to dispose of poison-ivy is to send it to the local landfill in plastic bags or bury it in the soil where it can decompose.

Once poison-ivy has been contacted, *immediate* washing with a strong soap or detergent may lessen the degree of infection. It is reported that the jewel-weed or touch-me-not *(Impatiens capensis)*, when crushed and rubbed on the infected area soon after contact, will reduce the severity. Mild cases can be treated with commercial preparations but severe cases should be referred to a physician.

While poison-ivy plants can be removed temporarily by hand removal and digging, the only sure way to kill the roots is by use of an herbicide. The ones most used are 2,4-D, silvex, amitrol and ammonium

HOW TO TREAT UNWANTED WOODY PLANTS

Foliage sprays of brushkillers diluted with water are commonly used on small trees or thick stands of mixed species. They can be applied from the time foliage is fully developed until plants begin to go dormant. For kill, all leaves, stems and suckers must be thoroughly wet to the ground line. Some regrowth may be expected on resistant species such as ash, oak and persimmon.

Basal sprays can be applied in any season. The usual procedure is to mix the brushkiller with kerosene or furnace oil and thoroughly wet the basal 10 to 15 inches of every stem or trunk (all around) until the spray collects around the root collar at the ground line. Basal sprays are used on scattered brush, or as a second spray on species resistant to a first foliage spray. They minimize danger to desirable plants nearby.

Semi-basal sprays are also used selectively, primarily by commercial applicators. The diluent is a combination of oil and water, and the technique involves thorough application to the lower two-thirds of the plant.

Stump treatment with brushkiller diluted with oil prevents resprouting and can be used at any time of year. It is most effective when applied as soon as possible after trees (3 to 4 inches in diameter or larger) have been cut. Spray the entire stump, particularly bark and exposed roots. Thorough drenching is essential for kill.

Frill treatment involves using an axe to cut overlapping notches in a continuous ring around the trunk line near its base. Cut through the bark but do not remove chips. Pour in as much of the brushkiller mixed with oil as the frill will hold. This method is recommended for cull trees 5 to 6 inches or larger in diameter.

Follow manufacturer's directions for specific plants, for concentrations of herbicides to be used, and for exact methods of application.

sulfamate. Most county and state extension services will have publications dealing with the chemical control of poison-ivy.

Ragweed

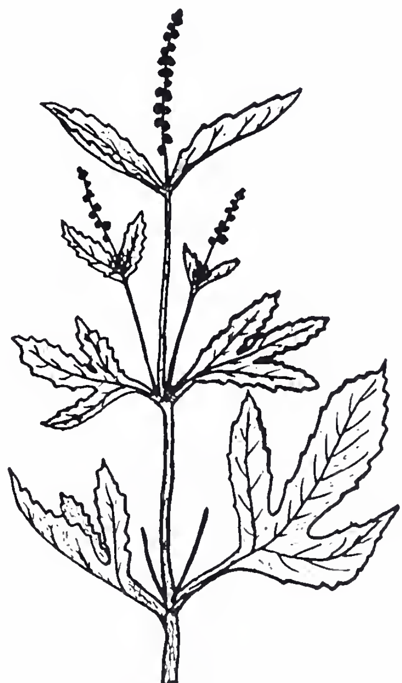
On or about August 1 a curious medical phenomenon will occur. Long lines of red-eyed, sniffling patients will line up at allergists' offices. They are seeking relief from the miseries of "hay fever." How many people will be in line? Millions, or between 5 and 10 percent of the population.

This "hay fever" is more commonly caused by ragweed than by hay. Ragweed comes in two sizes, common and giant. The common ragweed *(Ambrosia artemisiifolia)* is a small plant, about 3 feet high with fern-like, deeply cleft leaves. The giant ragweed *(Ambrosia trifida)* grows much taller, from 5 to 15 feet high, depending on moisture and fertility. Its leaves are usually three-lobed.

Common ragweed generally prefers dry sites and is especially prevalent in freshly turned soil. For that reason, it is very thick on new sewer or water lines and where new houses are being built. Giant ragweed prefers more moist sites so it is found mostly along drainage ditches or in low areas. They both, however, are tolerant of a variety of soil and site conditions and are often found growing together in vacant lots in cities.

The one thing these plants have in common is the greenish-white flowers in long terminal spikes. These are the pollen-producing male flowers. The female flowers are located inside the plants at the stem and leaf axils. During August and September, the male flowers throw

Common Ragweed



Giant Ragweed

off huge quantities of dusty yellow pollen. Each square mile of ragweed growth produces about 16 tons of pollen per season.

Recent studies show that pollen released by the flowering ragweed plant along highways and places where people live, work, or play, causes a greater antigenic response in persons suffering from hay fever than the ragweed pollen carried for several days by air currents over long distances. While it takes hot, dry, windy conditions to cause the plants to release pollen, these same conditions act to reduce the viability and ability of the pollen to cause antigenic reactions. This means that local, intensive ragweed control programs can aid greatly in reducing the miseries of hay fever sufferers and can permit the acute or chronic hay fever patient to respond more favorably to treatment given by allergists.

Many municipalities have ragweed control programs. Usually a survey is taken to determine the amount and location of ragweed plants. Then a decision is made whether to use cultural or chemical methods of control. Cultural methods usually involve clipping with some hand removal in difficult areas. Clipping should not be started too early as regrowth may occur. The chemical 2,4-D has proven to be a safe, inexpensive, effective herbicide to control ragweed. Details on this and other methods of control are available from your extension service.

WEED-CONTROL ARITHMETIC

CONVERSION FACTORS FOR THE USE OF HERBICIDES

t = level teaspoon
T = level tablespoon
(standard kitchen measuring spoon)

3 t = 1 T	2 cups = 1 pint
2 T = 1 fluid ounce	2 pints = 1 quart
16 T = 1 cup or 8 fluid ounces	4 quarts = 1 gallon

1 gallon water = 8.34 lbs.
1 gallon = 3785 ml. (milliliters)
2 lb. per 100 gal. = 0.32 oz. per gal.

AREA APPLICATIONS

1 acre (A) = 43,560 sq. ft.
1 ounce = 28.34 grams
1 fluid ounce = 29.57 ml.
1 pound per acre = 0.0104 grams per sq. ft.

Example: A granular material is recommended at 100 lb. per acre. How much does one use on 100 sq. ft.?

Calculation: 1 lb. per A = 0.0104 grams per sq. ft. = 1.04 grams per 100 sq. ft.
100 lb. per A = 104.0 grams per 100 sq. ft.

$$\frac{104.0}{28.34} = 3.66 \text{ oz. (little less than } \tfrac{1}{4} \text{ lb.)}$$

Example: A liquid is recommended at 100 gallons per acre. How much does one use on 100 sq. ft.?

Calculation: 1 gal. per A = 0.08689 ml. per sq. ft. = 8.689 ml. per 100 sq. ft.
100 gal. per A = 868.9 ml. per 100 sq. ft.

$$\frac{868.9}{29.57} = 29.38 \text{ oz. (little less than 1 qt.)}$$

From *Pesticide Handbook*, Miscellaneous Publication No. 8, Virginia Cooperative Extension Service, 1965.

Persistent efforts required to combat this robust immigrant

JAPANESE HONEYSUCKLE

Silas Little

IF planted where it cannot spread—as in a city garden—or for purposes of preventing soil erosion, Japanese honeysuckle can be an asset as a vigorous climber or ground cover, but in other situations it becomes an overwhelming pest that invites eradication.

Japanese honeysuckle spreads in two ways—by sending out long runners from existing root systems and by establishing new seedlings. Birds, eating the fruit, are probably responsible for the long-distance spread of the plant. The initial growth of seedlings is slow, but by the third or fourth year they may be well enough established to send out runners 4 to 8 feet long.

Growth from established root systems is much more rapid than that of new seedlings. Where runners have been killed by herbicides, new root sprouts grow rapidly: the total length of laterals and sublaterals produced by one sprout in one year was 46 feet; and the average growth of marked sprouts was 25 feet. The honeysuckle can usually regain its original density within two years.

Even though honeysuckle recovers rapidly after being severely damaged, elimination of an infestation is possible. The slow rate of reinvasion by new seedlings is one of the few bright spots in the problem of controlling this vine.

Clean cultivation. Scattered runners can be pulled up by hand. A bulldozer equipped with a root rake can eliminate dense mats, though some scattered sprouts usually regenerate. Repeated mowing will hold the vines in check, but will not eliminate them.

Herbicides. If rocks, trees, steep slopes or streams make these methods undesirable, weed killers may be the most feasible method of control. In experiments conducted by the Northeastern Forest Experiment Station, several have proved effective on honeysuckle in varying degrees.

(1) Use a low-volatile 2,4-D in a high-volume spray to reduce the possibility of damage from volatility and drift. Either an emulsifiable acid formulation or any of the low-volatile ester formulations can be recommended.

(2) Mix at the rate of 4 to 8 pounds of the active ingredient in 100 gallons of water. The 8-pound rate is usually more effective.

(3) Thoroughly wet all honeysuckle foliage within 4 feet or so of the ground. If vines are climbing over trees or shrubs, cut or pull down those extending above 4 feet. In the initial application use about 100 gallons of the spray mixture per acre. Although this treatment is most effective on hot clear days in the period between late May and early September, early-fall applications work almost as well, and the resulting brown foliage will be less noticeable then.

(4) At annual intervals repeat the spraying. Volumes required then will be less, but more care will have to be taken to find and treat scattered runners. Three or four treatments are usually sufficient.

While the materials, picloram and dicamba, are highly effective on Japanese honeysuckle, they are not recommended for homeowners. Foliage sprays of them may be highly damaging to adjacent vegetation, and an effective treatment may have so much residual effect that the establishment of other plants is prevented for a year or more. If used, they should be handled with great caution and only by trained operators. Since the registration and permissible use of herbicides are under constant review by state and federal authorities, a responsible state agency should be consulted on the current status and permissible use of any chemicals for honeysuckle control.

Two knotweed species that are variously classed as garden plants, wild flowers or weeds

JAPANESE-BAMBOO

A. M. S. Pridham and Arthur Bing

WHETHER the plant known as Japanese-bamboo is friend or foe is a question the gardener who has it must decide for himself. It is not a bamboo, nor even remotely related to the bamboos (which are woody grasses) but is one or another species of knotweed *(Polygonum)* and is either *P. cuspidatum* from Japan or the larger, coarser, more scantily flowered *P. sachalinense* from the island of Sachalin, north of Japan and Korea.

These two species were introduced into the United States in the late 19th century, the Japanese species as an ornamental, largely for its lacy whitish flowers in September, the other in part for foliage effects. They also have been planted for erosion control along road cuts, both railway and highway, as well as on private property. Individual plants or clumps left alone without care will increase and can be useful as landscape plants. Both kinds have large, somewhat heart-shaped leaves ranged along hollow, arching, reddish stems which grow very rapidly to a height of 5 or 6 feet.

Because the annual stalks of both these species are killed by the first light frost, farmers are more likely to look upon the plants as frost indicators rather than as ornamentals. At this stage they are no longer decorative, and gardeners often object to having to tidy up the brown foliage that is not shed until late fall and the long dead stalks that would remain standing over winter.

The ability to grow and persist in rough places where little else can thrive means that in better ground these large knotweeds overwhelm all other vegetation. For years, most attempts to eradicate them have been futile.

Digging the plants can be quite a chore since the underground stems grow to 5 feet or more. Hoeing or cutting them is a fine way to encourage new and more profuse growth. A two- to four-year program of removing all young shoots is a surer way of getting the situation in hand.

Control Methods

There are no surefire cultural practices that will control Japanese knotweed. Covering an infested area with 2 inches of asphalt in a driveway is futile as the new shoots push right through the asphalt. Several layers of black polyethylene film tightly applied to a leveled soil surface and covered with asphalt, patio blocks or stones may be an answer to the problem (but at considerable price for the average homeowner).

Many contact herbicides, such as kerosene, sprayed on the foliage will burn the leaves and partly kill the stems. Repeated spraying of the new foliage will weaken the plant and, in time, could possibly kill it. Because Japanese-bamboo has a large underground food reserve, this method may not be successful unless practiced consistently for a long time.

Use of Systemics

The most practical method for eliminating perennial weeds with large roots with vast food storage capabilities is to spray the foliage with a systemic herbicide. This is absorbed by the leaves and carried through the plant to kill the roots and tops. This type of herbicide must be used carefully. Avoid spraying or allowing drift to touch the foliage of desirable plants as severe damage can occur.

Some systemics, such as dicamba (Banvel D), are very long lasting and could leach through the soil and reach roots of desirable trees with disastrous results. Very few herbicides of this type

George Taloumis

Left: Young clump of Japanese-bamboo showing the large, heart-shaped foliage. **Right:** A grove or colony of Japanese-bamboo displays the dense growth that is typical of established plantings. Although mature stems bear a superficial resemblance to bamboo, the plants are not related to bamboo at all, but are a species of knotweed (*Polygonum*).

are available for use around the home. The 2,4-D formulations used to control dandelion, plantain and many other common broadleaved weeds in lawns are not effective against Japanese-bamboo. However, dicamba, which is available for homeowner use on lawns in combination with 2,4-D to get rid of difficult broadleaved weeds, is effective against Japanese-bamboo. (Some of the trade names are Super D and Weed-B-Gon.) It can only be used in open areas away from trees and other desirable broadleaved (non-grassy) plants. Repeated sprayings of the Japanese-bamboo foliage with this combination could bring it under control. Cutting the plants down in late spring and spraying the regrowth is probably the more effective procedure. Use low pressure and a coarse spray to avoid drift to desirable plants.

In the Future

There are experimental herbicides that show great promise for the control of persistent perennial weeds including Japanese-bamboo. Studies are being made with systemic herbicides that are long lasting in the plant but leave no residue in the soil. The use of such herbicides would make it possible to eliminate Japanese-bamboo without the danger of harmful residues in the soil that leach down to injure tree roots. However, the danger of drift would still be with us. When such systemics are sufficiently studied and tested for safety and effectiveness, some may be labelled for homeowner use.

That a chemical is effective against a weed is not sufficient justification for its use. All aspects of safety to other plants, animals and the environment must be considered before a registered use is put on the label of a chemical. Some chemicals that can be safely used on farms or along highways may not be safe around the home.

Sources of Information

As the labelling of chemicals is a continuous process, it is best to consult your local county agricultural agent or other local authority for the latest recommendations for chemical control of Japanese-bamboo and similar persistent weeds.

A long growing season for lawns—and weeds

WEED CONTROL IN WARM-CLIMATE LAWNS

James F. Miller

WEEDS can be a problem in lawns grown under warm-climate conditions, because it is difficult to maintain a lawn in optimum growing condition for nine to twelve months of the year. Herbicides (chemical weed killers) can be used to prevent or destroy weed infestations.

Lawn Weeds

Weeds can be divided into specific categories to help you decide what kind of weed killer should be used and when to apply the control method:

Annual weeds germinate from seed; controlled by preemergence and postemergence chemicals.

Summer annuals emerge in the spring, grow during the summer and produce seed in late summer. Examples: Grasses—crabgrass, goosegrass; broadleaf weeds—spurge, knotweed.

Winter annuals emerge in fall or winter, grow during warm periods in winter and produce seed in spring. Examples: Grasses—annual bluegrass; broadleaf weeds—henbit, hop clover, medic, mustards, chickweed.

Perennial weeds grow from established root stocks for two or more years, reproduce by seed and/or vegetative means; established plants may be controlled by postemergence herbicides; germinating seeds of perennial plants may be killed by preemergence treatments. Examples: Grasses—fescue, dallisgrass; broadleaf weeds—dandelion, Florida betony.

When weeds are a problem in a lawn, you must determine what kinds of weeds are present in order to choose the proper herbicide for control and to apply the

Dallisgrass (*Paspalum dilatatum*) is a perennial grass, considered a weed in lawns. Its seeds can be controlled before they germinate by preemergent herbicides; plants are controlled by postemergent herbicides (see Tables 2 and 3).

herbicide at the most effective time.

Time of Herbicide Application

Preemergence—Apply herbicides before weed seedlings emerge. There are two preemergence herbicide application periods for weed control under warm-season conditions:

Spring treatments—commonly applied for crabgrass control. Timing may vary from February on the Gulf Coast to late April in more northerly areas. Consult local or state reference sources for specific suggestions.

Fall treatments—for control of winter annual weeds, such as annual bluegrass, henbit, etc. Generally early September in northerly reaches of southern U.S.; late October for coastal areas.

Preemergence treatments may be applied at any season or in any month, if needed to prevent emergence of weeds. In southern coastal areas, for example, crabgrass control may be maintained by preemergence applications at approximately three-month intervals, or four treatments each year.

Henbit (*Lamium amplexicaule*) is an annual broadleaf weed that can be controlled by both preemergent and postemergent herbicides. See Tables 2 and 3.

Annual bluegrass (*Poa annua*) is a fast-growing lawn weed controlled in warm climate lawns by a preemergent herbicide from September to November and January to February. See Table 2.

Table 1. LAWN GRASS TOLERANCE TO HERBICIDES

	Preemergence						Postemergence					
Grass	terbutol (Azak)	benefin (Balan, Balfin)	DCPA (Dacthal)	bensulide (Betasan)	pronamide (Kerb)	atrazine	Arsonates (DSMA, MSMA, AMA)	endothall	2,4-D[1]	paraquat	pronamide (Kerb)	dalapon[3]
Bermudagrass	T	T	T	T	T	S-I	T	T*	T	S-I*	T	S
Zoysia grass	T	T	T	T	T	S-I	S-I	T*	T	S-I*	T	S
Centipedegrass	T	T	T	T	T	T	S	S	S-I*	S	T	S
St. Augustine grass	T	T	T	T	T	T	S	S	S	S	?	S
Fescue grass	T	T	T	T	S	S	T	S	T	S	S	S
Bahia grass	T	T	T	T	T	S	S	S	T	S	S-I	S
Seeded Mixtures	DO NOT USE								T[2]			

T = Tolerant; safe to use herbicide at recommended rates.
S = Sensitive; DO NOT use this herbicide.
S-I = Intermediately tolerant; use herbicides with care, since grass may be injured.
? = Unknown
* = Tolerant to herbicides when dormant; may cause damage to growing grass.
[1] = Includes silvex, dicamba.
[2] = Use ½ rate to reduce injury.
[3] = Use dalapon only for spot treatment or edging along walks, under fences, etc.

Postemergence—Apply herbicides after annual weeds emerge or when new growth or regrowth of perennial plants appears.

Nonselective postemergence herbicides, such as endothall or paraquat, should be applied only when tolerant lawn grasses are dormant (winter).

Selective postemergence herbicides, such as arsonates or 2,4-D, may be applied to established tolerant lawn grasses anytime sensitive weeds are present.

Weed Control

Warm-climate lawn grasses vary greatly in tolerance to certain herbicides. Table 1 provides a general guide to the sensitivity of various common lawn grasses to commonly used herbicides. There are many different varieties or strains of bermudagrass, fescue, zoysia and other lawn grass types. Various strains or varieties within a grass type may exhibit different responses to a specific herbicide due to biotic or environmental factors. Consult extension agents in your local area or state for more specific information on the use of herbicides on lawn grasses grown under your environmental conditions.

Weed Control for a New Lawn

Preemergence herbicides can be applied after seeded grasses (fescue, centipede, common bermudagrass, fall/spring-seeded mixtures) have emerged and are well established. Rule of thumb—after grasses are three to four inches tall or begin to "run," apply one-half normal rate. *Do not apply preemergence herbicides before or immediately after seeding!*

Do not seed or reseed lawn areas which have been treated with normal rates of preemergence herbicides until residues have disappeared (usually three to four months).

Postemergence herbicides can be applied at one-half rates after seeded grasses are two to three inches tall or after they begin to "run."

Competition from annual grasses and weeds can reduce the growth rate of sprigged lawn grasses (zoysia grass, bermudagrass, St. Augustine grass and centipede grass sprigs). Herbicides can also slow the rate of growth. However, growth

TABLE 2. WEED CONTROL SCHEDULE FOR LAWNS

Time of Application	Weeds	Herbicide*	Rate/1000 Square Feet	Remarks
May and as needed through summer	crabgrass, dallisgrass, goosegrass, nut-sedge	DSMA or MSMA (many different trade names)	1-2 Tbs. or See label	Apply 3 to 4 days after mowing when weeds are 2 to 3 inches tall. Repeat treatment after 7 to 10 days. Do not use on centipede or St. Augustine grass.
	spurge, knotweed, mallow, nut-sedge, general broadleaf weeds	2,4-D (amine) or 2,4-D + silvex or 2,4-D + silvex + dicamba + MCPP	1-2 Tbs. or See label	Spray to wet the leaves when no rain is expected for 6 to 8 hours. Repeat treatment in 7 to 10 days to control hard-to-kill weeds. Do not apply to St. Augustine grass; may injure centipede.
September to November	annual bluegrass, annual winter weeds	DCPA (Dacthal) or terbutol (Azak) or benefin (Balan) or bensulide (Betasan) or pronamide (Kerb)	8-10 Tbs. 7-9 Tbs. 2-3 Tbs. or See label 2-5 Tbs.	Apply before annual bluegrass germinates. Available as granular formulations. Apply label rate.
November to December	wild garlic, wild onion	2,4-D (ester or amine)	2-4 Tbs. or See label	Apply in early December before new bulbs are formed. Use detergent or commercial sticker to aid wetting of weed leaves. Also controls emerged annual weeds.
January to February	annual winter weeds (annual bluegrass, chickweed, henbit, clovers, etc.)	endothall (Endothal) or pronamide (Kerb)	See label 2-5 Tbs.	Repeat treatment after 7 to 10 days. DO NOT apply to centipede or St. Augustine grass. Apply to other lawn grasses only when DORMANT.
	wild onion, wild garlic	2,4-D or 2-4-D + silvex + dicamba (ester or amine)	2-4 Tbs. See label	Apply second treatment in February or March (first treatment in December) to kill plants which emerged since December. Continue this program for 3 years to get good results. This schedule will kill other winter weeds except annual bluegrass.
March to April	crabgrass, other annual summer grasses and broadleaf weeds	DCPA (Dacthal) or terbutol (Azak) or benefin (Balan) or bensulide (Betasan)	8-10 Tbs. 7-9 Tbs. 2-3 Tbs. See label	Apply before weeds and grasses germinate.

* Formulations under different trade names may also differ in concentration of active ingredient. Tbs = Tablespoons. Apply these rates in 1 gallon of water or more per 1,000 square feet.

reduction by herbicides generally is less than that from weed competition.

Preemergence treatment—Immediately, or within one to two days after sprigging, apply a preemergence herbicide at one-half the rate recommended for established grasses. Apply water to the treated area immediately to activate the herbicide. Delay in applying the herbicide or water may allow weed seedlings to emerge. Weeds which escape the herbicide may be stunted, but will recover to compete with the grass.

Do not apply preemergence herbicides to newly seeded bermudagrass, centipede or seeded-mixture lawn grasses. Do not use benefin (Balan or Balfin) on newly seeded or sprigged grasses.

Postemergence treatment — Arsonate herbicides, such as DSMA, MSMA, AMA (a variety of trade names), will control crabgrass and other annual grass seedlings which escape preemergence treatments. Repeat the postemergence treatment each time new weed seedlings emerge.

Apply low rates to reduce the possibility of injury to the lawn. Do not apply to centipedegrass. For best results, spray weedy grasses in the two- to four-leaf

TABLE 3. RESPONSE OF SOME COMMON WEEDS TO HERBICIDES

ANNUAL WEEDS	Preemergence						Postemergence						
Grasses (W)—winter (S)—summer	DCPA (Dacthal)	terbutol (Azak)	benefin (Balan)	bensulide (Betasan)	pronamide (Kerb)	atrazine[1]	arsonates (MSMA) (DSMA)	2,4-D silvex	dicamba	endothall	paraquat	pronamide (Kerb)	dalapon[2]
Annual bluegrass (W) *(Poa annua)*	E	E	E	E	E	E	P	P	–	E	E	E	–
Crabgrass (S) *(Digitaria sp.)*	E	E	E	E	G	G	E	P	–	–	–	P	–
Goosegrass (S) *(Eleusine indica)*	E	E	E	E	G	G	G	P	–	–	–	P	–
Crowfootgrass (S) *(Dactyloctenium aegyptium)*	E	E	E	E	G	G	E	P	–	–	–	P	–
Broadleaf Weeds													
Black medic (W) *(Medicago lupulina)*	F-G	G	P	G	P	E	F	G	E	E	E	–	–
Common chickweed (W) *(Stellaria media)*	G	G	G	G	E	E	E	F-G	E	E	E	F	–
Henbit (W) *(Lamium amplexicaule)*	G	G	G	G	–	E	G	G-E	E	E	E	F	–
Speedwell (W) *(Veronica sp.)*	G	G	G	G	E	E	G	E	E	G	E	F	–
Evening-primrose *(Oenothera sp.)*	F	G	F	F	G	E	P	E	E	G	G	P	–
Hop clovers (W) *(Trifolium sp.)*	G	G	P	G	P	E	G	G-E	E	E	E	P	–
Lespedeza (S)	G	G	F	G	–	E	F-G	G	E	–	–	–	–
Knotweed (S) *(Polygonum aviculare)*	G	G	G	G	–	E	F	F-G	E	–	–	–	–
Spurges (S) *(Euphorbia sp.)*	G	P	G	G	–	E	F-G	F-G	E	–	–	–	–
Wood sorrel (S) *(Oxalis sp.)*	G	G	G	G	–	E	G	F-G	E	–	–	–	–
Pepperweed (W) *(Lepidium sp.)*	G	G	G	G	–	E	G	G	G	G	E	–	–
Spurweed *(Soliva sp.)*	G	G	G	G	P	E	F	F-G	E	E	E	P	–
Mustards (W)	F	G	F	–	–	E	F	G-E	E	G	E	P	–

stage when weather is warm and the soil is moist. If treatment is delayed and weeds are large, higher rates needed for control may produce more injury to the lawn.

Most broadleaf weeds can be controlled by mowing until the lawn is well established. Mowing is preferred over the use of 2,4-D until the lawn is well established, since 2,4-D may injure new sprigs.

Weed Control on an Established Lawn

Most homeowners are concerned with either preventing weed infestations or destroying weed infestations in lawns that are well established. Table 2 suggests a year-round weed control schedule.

Table 3 may help you decide which herbicide and which time of application will most effectively control the kinds of weeds found in your lawn.

PERENNIAL WEEDS	Preemergence						Postemergence						
Grasses (W)—winter (S)—summer	DCPA (Dacthal)	terbutol (Azak)	benefin (Balan)	bensulide (Betasan)	pronamide (Kerb)	atrazine[1]	arsonates (MSMA) (DSMA)	2,4-D silvex	dicamba	endothall	paraquat	pronamide (Kerb)	dalapon[2]
Bermudagrass (S) *(Cynodon dactylon)*	P	P	P	P	P	P	P	P	P	P	P	P	E
Dallisgrass (S) *(Paspalum dilatatum)*	P	P	P	P	P	P	E	P	P	P	P	P	E
Bahiagrass (S) *(Paspalum notatum)*	P	P	P	P	P	G	E	P	P	P	P	G	E
Tall fescue (W) *(Festuca sp.)*	P	P	P	P	P	P	P	P	P	P	E	E	E
Carpetgrass (S) *(Axonopus affinis)*	P	P	P	P	P	P	E	P	P	P	P	P	E
Broadleaf Weeds													
Plantain (W) *(Plantago sp.)*	P	P	P	P	P	E	P	E	E	F	P	P	P
Dandelion (W) *(Taraxacum sp.)*	P	P	P	P	P	G	P	E	E	F	P	P	P
Clovers (W) *(Trifolium sp.)*	P	P	P	P	P	E	G	F-G	E	E	F	P	P
Dichondra (S) *(Dichondra sp.)*	P	P	P	P	P	E	P	F-G	E	P	P	P	P
Sorrel (W) *(Rumex sp.)*	P	P	P	P	P	E	P	G-E	E	G	P	P	P
Docks (W) *(Rumex sp.)*	P	P	P	P	P	E	P	G-E	E	F	P	P	P
Mouse-ear chickweed (W) *(Cerastium sp.)*	P	P	P	P	P	E	P	F-G	E	E	E	P	P
Mallow (S) *(Malva sp.)*	P	P	P	P	P	E	P	F-G	E	P	P	P	P
Hydrocotyle (S) *(Hydrocotyle sp.)*	P	P	P	P	P	G	P	F-G	E	P	P	P	P
Florida betony (S) *(Stachys floridana)*	P	P	P	P	P	E	P	F-G	E	P	P	P	P
Other Weeds													
Wild garlic (W) *(Allium sp.)*	P	P	P	P	P	P	P	G-E	G	F	G-E	P	P
Nut-sedge (S) *(Cyperus sp.)*	P	P	P	P	P	P	G	G	G	P	P	P	P

[1] Not generally recommended. [2] Nonselective—kills all grasses and many broadleaf weeds, used for edging, etc.
E = Excellent control at recommended rates.
G = Good control at recommended rates.
F = Fair control at recommended rates.
P = No control or poor control at recommended rates. NOT RECOMMENDED FOR CONTROL due to grass tolerance, weed tolerance or some other factor.

RECOMMENDED READING ON WEEDS

Elizabeth C. Hall

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Crafts, Alden S. *Modern Weed Control.* 440 pages, illustrated. University of California Press, Berkeley, 1975.

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Kingsbury, John M. *Deadly Harvest; A Guide to Common Poisonous Plants.* 128 pages, illustrated. Holt, Rinehart and Winston, New York, 1965.

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Martin, Alexander C. *Weeds.* (Golden Guide) 158 pages, illustrated, some color. Western Publishing Co., New York, 1973. Hardcover and paperback.

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Weaver, Robert J. *Plant Growth Substances in Agriculture*. 594 pages, illustrated. W. H. Freeman and Co., San Francisco, 1972. $19.50.

Weed Control Manual and Herbicide Guide. 74 pages. Meister Publishing Co., Willoughby, Ohio, 1971. $5.00 (paper).

Wilkinson, Robert E. and Harry E. Jacques. *How To Know The Weeds;* 2nd ed. (pictured—Key Nature Series) 232 pages, illustrated. William C. Brown Co., Dubuque, Iowa, 1972. Hardcover and paperback.

HOW TO COPE WITH KUDZU

Kudzu (*Pueraria lobata*), a strikingly handsome vine of the pea family, is a familiar sight along southern roadsides. The trouble is, this Asiatic import, whose shoots can grow up to 60 feet a year, doesn't stay put. Many thousands of acres are now covered wiht its lush, almost haunting foliage, leading a Georgia reporter, Joel Blackwell, to call it the vine that ate the South (PLANTS & GARDENS, Winter 1974-75, pages 29-30). The great spread of kudzu has occurred mostly in the short time of forty years. It has the reputation of being the fastest-growing vine in the United States. What can the homeowner do about the encroachment of kudzu in his backyard? P & G called Harry Ponder of the Atlanta Cooperative Extension Service. After a chuckle or two when asked if the query came his way often, Dr. Ponder stressed that there is a difference between "control" and "eradication." One of the control recommendations is chlorflurenol, a growth regulator sprayed around the periphery. Kudzu responds fairly well to this, although two applications may be necessary. The contact herbicide paraquat also knocks back the edges, acting very much like a chemical pruner. Dicamba is suggested for the eradication of kudzu. Dr. Ponder emphasized that whatever herbicide is used, it is essential to follow the label instructions carefully.

TERRARIUMS

A HANDBOOK

- **Bottle Gardens**
- **Terrarium Plants—Orchids & Ferns & Insectivorous Plants & Others**
- **Making a Terrarium from Acrylic & Wood**
- **Desert Gardens**
- **Water Gardens**
- **Sources of Supplies**

PLANTS & GARDENS

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

TERRARIUMS
A HANDBOOK

Vol. 31 Autumn (November) 1975 No. 3

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Photographs by Brenda Weisman

Above: Much of the terrarium revival today is sparked by a marriage between the plastics industry and imaginative design concepts. Typical of the design revolution is the bubble-shaped container (above). In this one Sally Freedman has combined a variety of tropical plants that thrive in the special environmen provided by a terrarium.

Right: A closer look at this bubble terrarium, which includes both flowering as well as foliage plants.

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Terrariums are back these days and many indoor gardeners are finding new pleasures in creating them. They are ideal for our busy lives, requiring little preliminary effort and post-natal care while bringing an extra touch of beauty, even elegance, to our homes and apartments. The variety of plants that can be grown in them is very substantial (and increasing every day), so the Botanic Garden has turned to Guest Editor Brenda Weisman and fourteen fellow Contributors to tell us about them. Let us take this opportunity to thank our authors for this primer on the modern Wardian cases.

Nathaniel B. Ward, in case anyone still doesn't know, is to terrariums what Linnaeus is to botany. If he didn't exactly start it all, this nineteenth-century London physician opened the floodgates of interest by describing his experiments for everyone. Like many advances in civilization, the first observation happened by accident, for Dr. Ward was merely trying to make a hawkmoth chrysalis develop in a closed bottle (north window of course). To his surprise a male fern, one of the world's commonest sorts, sprouted—and that was the last we heard of the chrysalis. Suburban gardeners won't be astonished to learn that the next plant to spring forth in Dr. Ward's bottle was annual bluegrass.

The world may be lucky the fern came first, not the bluegrass, for the London of that time was captivated by green fronds and fiddleheads. As Ward mentioned in his book *On the Growth of Plants in Glazed Cases* (1842): "I am quite ready to confess, that if some groundsel or chickweed had sprung up in my bottle instead of the fern, it would have made no impression on me." The fern lived nearly four years in its original container.

The greatest import of the discovery was that plants, particularly tropical and other mild-climate kinds of vast economic potential, could be safely shipped long distances in a tight glass box. Simple: Let light in, preserve humidity, and keep salt air out. Tea plants went from China to India this way, cinchona trees (the source of quinine) from Latin America to southern Asia. The Wardian case, or terrarium if you will, contributed in no small way to the consolidation of the British Empire.

Back to Dr. Ward's little treatise. Following the initial experiment, the good physician went on to build bigger and better terrariums after office hours. One of them, dubbed Tintern Abbey, included twinflower, primula, herb robert and kenilworth-ivy. Others had begonias, cyclamen and (horrors!) cacti. A man of no waste, he also fed his pet canary the seed from the common wood-sorrel (oxalis), mimulus and cardamine raised in the Wardian case. And one of his suggestions, for raising radishes and salad greens in the terrarium to help it pay its way in a year, may seem timely today.

Another remark by the practical doctor perhaps bears repeating today: "I must caution against indulging a taste for what are called fancy flowers—things which this year are rewarded with gold medals, and the next are thrown upon the dunghill." The purpose of Mrs. Weisman and her all-star group of Contributors is to steer us toward the terrarium plants that have proved best in their experience.

One last note: With the resurgence of terrarium popularity, digging certain plants from the wild may further diminish our native flora. If in doubt whether a species is in jeopardy, write your state department of environmental conservation for a list of endangered species. Write for it anyway—it should be in the hands of all who care about plants.

Frederick McGourty, Jr.

Editor

P.S. Don't forget the value of the terrarium as a propagation chamber. Most all the common house plants can be increased this way.

Two plants, the flowering *Sinningia pusilla* and *Saxifraga stolonifera* 'Tricolor' with handsome variegated foliage, are the sole occupants of this cylindrical terrarium.

Photographs by Brenda Weisman

THE BASIC TERRARIUM

Brenda Weisman

LURKING in the gardening pasts of most of us are little jungles sealed in glass that seemed to last forever. We referred to them as "terrariums" and their longevity was a source of pride. Although a miniature jungle or two can still be found (I have one!), the Age of Technology has caught up with terrariums and a whole new aspect of indoor gardening has developed. In fact, there even exists a Terrarium Association.

The first glass gardens many of us experienced were of the North Woods type —usually with disastrous results in our hot, dry homes. They were dormant much of the year and cooked to death in the winter. However, this kind of terrarium can be exceptionally beautiful, given much cooler winter temperatures than we humans care to tolerate. (For more information on the North Wooders, see page 51 and articles in BBG Handbooks No.'s 38, 58 and 70.)

Ultimately, the need for more scope than woodland plants could offer led to the first major change in terrariums. This was the use of common foliage house plants, including ferns, the great indoor adornment of another period—the Victorian era. The new plants were not endangered species stripped from boreal forests but nursery-grown, tropical, jungle-floor sorts like aroids, pileas, tradescantias and, eventually, many others. As house plants, they, too, often died in our arid homes, but they survived, and rampantly, in overgrown brandy snifters and discarded aquariums. The key factor, of course, was humidity.

Purists resisted open tops to terrariums, but gradually the benefits to both plants and people of less rigid outlooks became so obvious that it just did not matter any more. Now one covers or not, according to choice and the air circulation requirements of individual plants. Epiphytic orchids can't be sealed in; terrestrials can. As long as humidity is maintained, everything else is planter's choice, mixed with a modicum of common sense. The experienced terrarium grower knows, for example, that plants with high light requirements, when grown in a closed container, will result in cooked greens in sunlight, but not under fluorescent tubes. Plants needing less light, on the other hand, can easily be covered wherever they are placed. Just remember that low light doesn't mean total eclipse!

Actively growing plants need 12-16 hours of light each day for best performance. Taking into account the amount of light required by the plants, that is, the total number of foot-candles necessary every 24 hours, greater intensities can be administered for less time or lower intensities for a longer time. This can be accomplished with any combination of artificial and natural light sources available, considering, of course, the photoperiodic responses of individual plants. In general, however, an obligate sun worshipper cannot thrive with 16 hours of much lowered light intensities, nor can the shy inhabitant of a shady nook in the wild survive if given even short exposure to intense light. It is of interest, though, that a cactus and succulent garden can be maintained beautifully, but with practically no growth, on a lamp table or north window in the winter if it is gradually moved into full sun outdoors for the summer.

Soils

The next consideration is the selection of the growing medium, generally referred to as soil throughout this discussion. The first reaction is that naturally it's soil, but a quick review of current house plant books reveals almost as many growing-mix recipes as there are growers—many of whom prefer not to use soil at all!

The most popular soilless mixes usually contain varying amounts of peat moss, vermiculite, perlite and, in some cases, fertilizer. Their overwhelming advantages —among them light weight, inability to become soggy and easy control of mineral nutrition—must be considered when a growing medium is chosen, but these merits can become liabilities without careful attention.

I prefer to have as few variables (and as little care) as possible in terrarium upkeep. The steady, necessary addition of fertilizer to soilless mixes may cause rampant growth or salt build-up. (By all means, though, give that reluctant African-violet an occasional sprinkle of fertilizer for encouragement.) Perlite, beside being extremely dusty, is frequently mistaken for mealybugs and has not found its way into my collection of ingredients—a personal prejudice to be sure. I don't care for vermiculite, either, for it normally floats. Just the merest overwatering in a terrarium causes it to shift around, disturbing root systems more than is necessary or desirable.

My plants live in the standard mix of one part sterilized soil (available in garden shops), one part finely sifted peat moss (sift it yourself or try to buy it that way) and one part builders' sand or bird gravel. Also, I add a little ground charcoal because of its ability to adsorb acids produced by the physiologic processes of plants and soil bacteria. These acids, left unchecked, can ultimately destroy a closed system such as a terrarium. In a constantly drained planting these impurities are ordinarily flushed away.

Care of Terrariums

Despite the wealth of plants now used in terrariums, I remain basically an afficionado of the "living room" terrarium, one that is designed to stay attractive in a north window or on a lamp table. This means using foliage plants almost exclusively, although many gesneriads, particularly miniature African-violets and sinningias, will bloom beautifully under these conditions for several years or more, provided they are not overgrown by their more exuberant neighbors.

Many of the tropicals are riotously luxuriant. They don't just passively remain as we have placed them. The aim is for ideal growing conditions, which means active growth, therefore judicious pruning to prevent legginess or terrarium romp. Gardens in glass are not static; they are and should be dynamic unless otherwise planned.

Terrarium plants require the same sanitation and grooming as their relatives on the outside. They also develop mealy bugs and spider mites. The grower is faced with the necessity of using pesticides, but how unproblematical these are in an enclosed space! Use an all-purpose house plant spray when needed, but first line the container sides with newspaper to protect against residue; or try one of the insecticide-impregnated pest strips. In either case, seal the terrarium immediately with tape or foil and keep it away from sunlight for a day or two. A third method is to scratch in systemic granules at planting time or later if necessary. Always read the label first before using any pesticide.

Thus, the creepers and crawlers, the suckers and the chewers are killed as are, occasionally, an exotic plant or two, but this is preferable to wholesale infestation. Usually when a terrarium is infested—and this doesn't happen nearly as often as with house plants grown under windowsill conditions—it's like an explosion. No one can pick off a thousand mealy bugs an evening, or aphids, or spider mites. So be on guard.

Fungus infections should be mentioned, too. Generally they are molds caused by overwatering, and they can be combatted with appropriate sprays. Often, just drying out the terrarium a bit solves the fungus problem. Mosses and other plants from the wild may harbor diseases, too, so look material over carefully.

A modified kitchen cannister contains *Selaginella*, *Peperomia rubella* and baby's-tears.

Watering

In fact, the key to a successful terrarium *is* the initial watering. Immediately after planting, it is best to water with a mist sprayer until the soil at the very bottom of the container is thoroughly darkened. This should be done no matter how large the container is, or how tedious the job. In very large tanks, clay pots can be sunk in the soil, covered with bark, rocks or sphagnum, and then water added as needed for darkening the visible growing medium. As long as the pots drain rapidly more water is required. The reason for such careful watering is to insure that the mix, particularly a soil mix, remains in the light, friable condition in which it was when originally placed. In pots or in the ground, a deluge destroys soil texture and can be deleterious, if not fatal, to roots. So please, a gentle spray.

In watering, the soilless mixes enjoy a tremendous advantage. If soil is inad-

A miniature greenhouse contains *Fittonia, Sinningia pusilla, Selaginella* and *Peperomia rotundifolia.* Too close planting in a terrarium means that jungle conditions will soon develop—avoid them by allowing generous spacing between plants from the beginning.

vertently overwatered, there is no remedy and one can just hope. If the perlite-vermiculite-peat combinations are overwatered, the excess not absorbed by the peat just sits there and can be removed with a kitchen baster. These mixes are truly non-absorbent.

There are no set rules for determining how much to water after the initial application. In an open terrarium, dish garden methods apply: look at the subsurface of the medium; feel it and water according to the plants' requirements. In a covered system, the look-and-feel system is important, too, but another, clearly visible, guide will be present—condensation. The terrarium holds the proper amount of moisture if the condensation takes the forms of slight fogging or small droplets on the container sides but still lets the plants be seen. Heavy fogging or sheets of water on the sides of the container indicate that the top should be removed for a few days so evaporation can take place. This may even have to be repeated a few times until the amount of condensation is acceptable.

Much is made of the need for proper drainage in the watering scheme. In fact, if one waters with a heavy hand no amount of drainage can compensate and, in practice, many fine growers provide drainage material while others of equal skill provide none at all. Here again, it's a matter of choice. Growers accustomed to using drainage layers also seem to have a sixth sense about proper watering and would likely be just as successful without such precautions. If too much water is given initially, no amount of sand and gravel will help.

Design

Having worked our way up through water, drainage, growing medium and pest control, each of which involves choices, let us turn to the design of the terrarium.

What choices there are! This is an area where one suits oneself. After lists of plants with the same or reasonably similar requirements are consulted and diminutives are seen on display either at the local nursery or nearest botanic garden, the appealing ones are purchased. The container, too, is bought or resurrected, and the planting mix is assembled.

Where to begin? Perhaps the easiest method is to decide whether the terrarium is to be viewed from one side, in which case "mountains" and taller plants are placed at the opposite side, or from all sides, which necessitates designing from the center to the outside. In the former situation, the light source must come from the front or above, so that the view is not marred by rear views of all the leaves, which is what happens to a window garden seen from the room. In the latter instance, the light source must come from above or else the container itself must be rotated frequently, again so that the leaves do not turn their backs on the viewer. A design can also be planned for top viewing on a lamp table.

The correct amount of soil initially placed in the container can be judged only by putting it in and deciding whether it looks right in relation to the size of the plants assembled. As a rule, filling about one quarter of the container is sufficient to begin with; more soil can be added or removed as the plants are placed. Also, one may use a sheet moss lining to hide the soil or not. I prefer to see the soil.

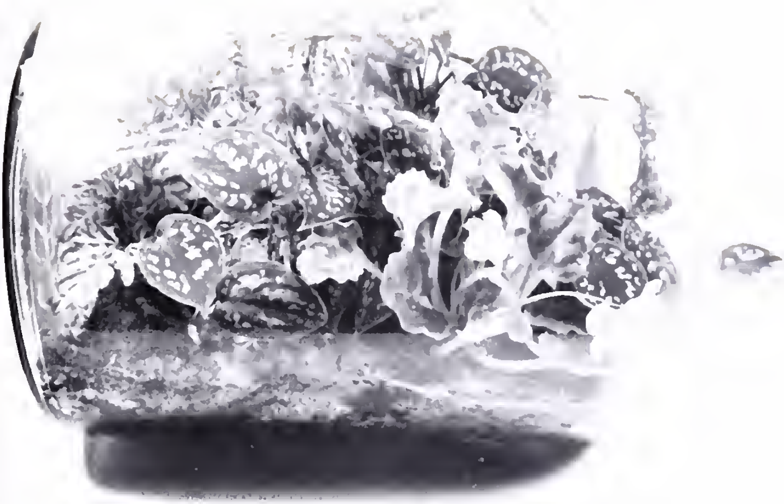
There is then the matter of actually placing the plants. It is best to select young plants in the smallest possible pot available. Young plants adapt more easily to new conditions than older ones, and a small pot usually insures a good root ball than won't fall apart when knocked out of the pot. This minimizes transplanting shock. However, should the root ball disintegrate, simply tuck the plant into the depression prepared for it, with the stem no farther under the soil than it was in the pot. Place soil over the roots. Gently pat everything into place and relax. Shock is less likely in the newly-made terrarium than in the maker.

From this point on, the design is up to you—hills and valleys to attract the eye, compatible plants dictated only by personal appeal, and of course, accessories that seem to blend with the scheme. Experiment with plants, with growing media, with containers, with elements of the environment. Don't accept blindly that one or another plant "can't" be raised in a terrarium! It usually can, under the right circumstances, and the full advantage of the terrarium may then be appreciated for its protection of well-grown plants from the vagaries of pets, people, an unfavorable, dry-as-a-bone climate and lengthy vacations.

THE TERRARIUM ASSOCIATION

FOND of begonias in old bottles, fiddleheads in fish tanks or wintergreen in Wardian cases? Does your mate yawn after you mention *Sinningia* 'Doll Baby' for the third time in five minutes? Worse yet, do you have an insatiable appetite for information on exciting new plants to try? Then you should know about a group of like-minded souls who have banded together to form the Terrarium Association.

The Association issues a newsletter "Terrarium Topics." Dues are $7.00 a year, with membership running through six issues of the publication. Back copies are available for 50¢ each. The editor, Robert Baur, who is a contributor to this Handbook, tells us that the Association, which started the newsletter in 1974, already has members in five countries. Address: The Terrarium Association, 57 Wolfpit Avenue, Norwalk, Connecticut 06851.



Brenda Weisman

With high hopes and a gentle manner . . .

A GARDEN IN A BOTTLE

Barbara Joan Grubman

A CLOSE FRIEND of mine creates the most delightful embroidery pictures. I look forward to trips to her home and am always surprised by her latest needleworks of art. I once asked her, "Where do you get your ideas?"

Her reply was simply, "I'll attempt anything. You see only the successes! There are many failures, too, but I try and learn and more often than not, I am pleased."

It occurs to me that this is an excellent way of approaching the making of a bottle garden. Certainly know-how and patience are essential, but don't overlook the spirit of adventure-in-creating that this woman so obviously has.

Come to the task of bottle gardening with high hopes and a gentle manner. Once you become familiar with the glassware available, the tools which are at your fingertips, supplies needed and steps in planting, you are well on the path.

When you begin looking, appropriate bottles will pop up everywhere. Seek out cider jugs, decanters, old chemist's flasks. Garage sales and attics will unearth all types of unusual narrow-necked bottles. The planting tools needed may already be in your own home or can be bought at a local hardware store at nominal cost. You will need the following: a funnel, a shovel, a placer, a tamper, a tweezer, a duster, a watering device, a pruner and a moisture tester.

The funnel should be sufficiently narrow to fit into the neck of the bottle yet wide enough to allow the soil to be poured through it to the bottom of the bottle. Cardboard rollers from the inside of gift wrapping paper make adequate funnels. A small kitchen funnel can be placed on top of this to make a wider top and avoid spillage. A shovel device, for digging plant holes, can be a long-handled iced-tea spoon or a wooden dowel.

Perhaps the most indispensable tool is the placer, which will transport the plant to the bottle's bottom. A young terrarium maker told me, "I find the common coat hanger, when straightened and looped on one end, makes a fine placer." The popular pick-up tool with a claw-like 'hand' on one end to grab the plant and a releasing mechanism on the other to free the plant once it is in the soil, is another good placer and is available in many stores.

After the hole has been dug and the plant placed, it needs to be secured in the soil. Glue a small cork to one end of the shovel dowel and let it serve as a tamping tool. A piece of sponge on the end of a straightened hanger can also firm the soil around the plant's roots.

If, after the planting, there are bits of debris or leaves to be taken out, use a long-handled tweezer such as the kind found in aquarium supply stores. A clean artist's-type paint brush, made longer by being taped to a dowel, will work as a duster for soil which has clung to the sides of the bottle. Its soft bristles also make perfect leaf cleaners.

Do initial and future waterings with a long-necked funnel or a kitchen baster. Pruning is a challenge but there will be times when dead or overgrown leaves need to be removed. This can be accomplished with a razor blade taped to your trusty dowel.

To test the soil for moisture, use a glass drinking straw or pipette. Push it down into the soil, remove a sample and feel for dampness. The appearance of the plants and the moisture which collects on the bottle also indicate whether more water is needed.

Soil choices are varied and there are a number of sterilized pre-mixes available for terrarium use. Many come complete with charcoal for sweetening and gravel for drainage. The soil should be light and airy to the touch but retain a certain firmness or body for plant support.

For the bottle garden, buy sturdy small plants adapted to moist conditions. Ones purchased in 2½ inch pots are usually the right size. Since the leaves and the stem have to pass through a narrow opening, initial plant size is important. Also, learn about the plant's growth rate and eventual size. If the plant is going to steadfastly push its way out of the top of the bottle in a month's time, it's not a candidate. Another precaution is to take your unplanted bottle with you to the garden shop and envision the plants inside of it before buying. Here are a few reliable and commonly available choices for the bottle garden:

baby tears (*Helxine*)
dwarf palm (various kinds)
prayer plant (*Maranta*)
peperomias
ferns and mosses
umbrella sedge
Chinese-evergreen (*Aglaonema*)

But, by all means try other plants, too, particularly as your confidence grows. Please your own tastes and sense of design. Remember that what may not work for me could very well be your pride.

Before the actual planting, gather all the materials, cover the work area with old newspapers, and set out the plants. If you every try to hold a plant upright in the soil and search for a tamper at the same time, you will soon see why this preparation is essential.

To prepare the planting bed in the bottle follow these steps:

1. With a dowel, place a bed of woodland moss (green side out) or damp sphagnum moss in the bottom of the bottle. Shape it into the form of a cup about one-quarter of the height of the bottle.
2. Put the funnel into the neck of the bottle and pour in several pieces of gravel for drainage, if it is not already in the soil mixture.
3. Add charcoal, if necessary.
4. Pour the soil in to the top of the moss cup.
5. Poke plant holes with the dowel.
6. Remove plants from their pots by gently tapping them on a table edge.
7. Wash roots and inspect for insects. Trim if necessary.

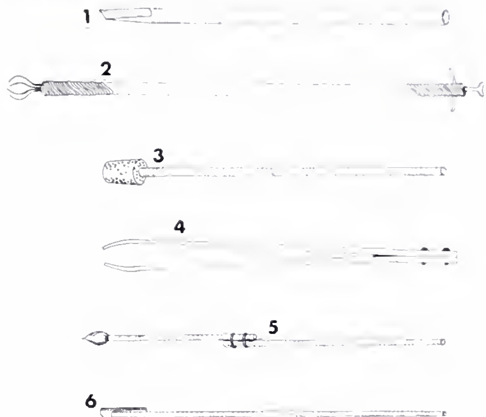
Before lowering the plants into their holes, decide which will be the front view. Then place your plants facing front. Taller plants should be set in the middle

BOTTLE-PLANTING TECHNIQUES

Bottle ready for planting. Soil has been added through funnel inserted in cardboard roller. Plants are removed from pots by inverting the pot on a table edge. Excessive root growth can be trimmed with a scissors if needed.

TOOLS OF THE TRADE

1 Shovel (a tapered dowel)
2 Placer (a "pick-up" tool with a "claw-like hand")
3 Tamper (dowel with cork)
4 Tweezers
5 Duster (paint brush tied to dowel)
6 Pruner (razor blade inserted in split end of dowel)



Stephen K-M. Tim

For the most growing room, smaller ones around them, and finally ground cover.

Try the following steps in planting:

1. Set the plant in the placer with the roots down and the top resting on the loop of the hanger or the prongs of the pick-up tool.
2. Ease the plant, roots first, through the neck of the bottle, gently tightening the leaves with your hand so they will fit.
3. Place the plant in the prepared hole; be careful not to mash the roots or let any parts touch the glass.
4. Secure the roots in the soil by covering them with a half-inch of soil and tamping it down.
5. Remove the placer and the tamper up through the neck.

For the first watering, pour half a cup of lukewarm water through a long-necked funnel to the bottom of the bottle, or sprinkle well with a laundry sprayer. Bottle gardens by their very nature are water-retainers, so future waterings may be rare or not needed at all. Place the finished bottle garden in a cool location and out of direct sunlight.

I do want to wish you good luck and happy times in bottle gardening. Let imagination be your guide. Be bold or conservative. Use a single striking fern or just three tiny ground covers if it suits your fancy. Then relax and drink a toast to your successes . . . but save that vin rosé bottle for the next project!

A pictorial guide to

PLANTS FOR THE TERRARIUM

Brenda Weisman

Plants for a terrarium to place in a north window all year—with perhaps some extra lamp light on winter evenings.

Left: *Scindapsus pictus argyraeus* is a favorite plant for the terrarium. It is one of the best for a large terrarium or bottle, or is a gem by itself in a brandy snifter or bubble. The coloring of its leaves is spectacular, yet it also combines well with other plants. It is slow growing, but if the necessity for pruning arrives, this is easily accomplished. A native of Borneo.

Left: *Saxifraga stolonifera*—a second favorite among terrarium plants an one of the most adaptable Although it prefers cool conditions, it does extremely well under all the house temperatures th I have experienced. (This saxifrage used to be called *S. sarmentosa* and i still known as strawberry-begonia or strawberry-geranium. Another common name, mother-of-thousands, seems the mos appropriate, though, considering the runners a single plant can produce.)

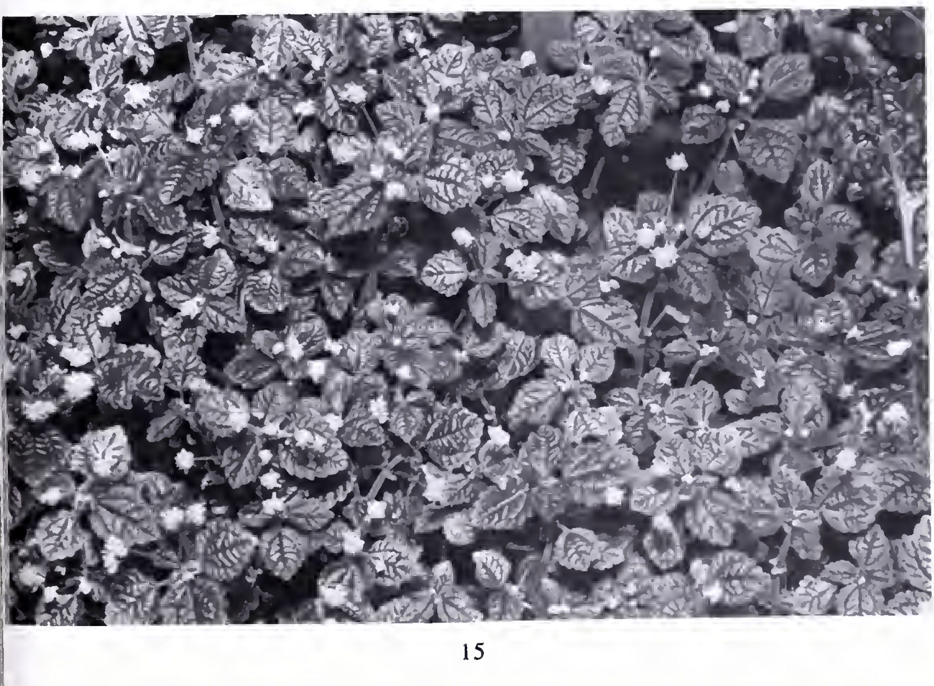
Right: *Saxifraga stolonifera* 'Tricolor'. A more spectacular version of the species—but also more delicate and slower growing. It does not produce runners with the abandon of the species, either—perhaps an asset in most terrariums.

Photographs by Brenda Weisman

Acorus gramineus variegatus is often called sweet flag from Japan. It has grasslike green and cream foliage. Because of its distinctive growth habit and appearance, this is a popular choice for terrarium "landscapes." It is quite slow growing.

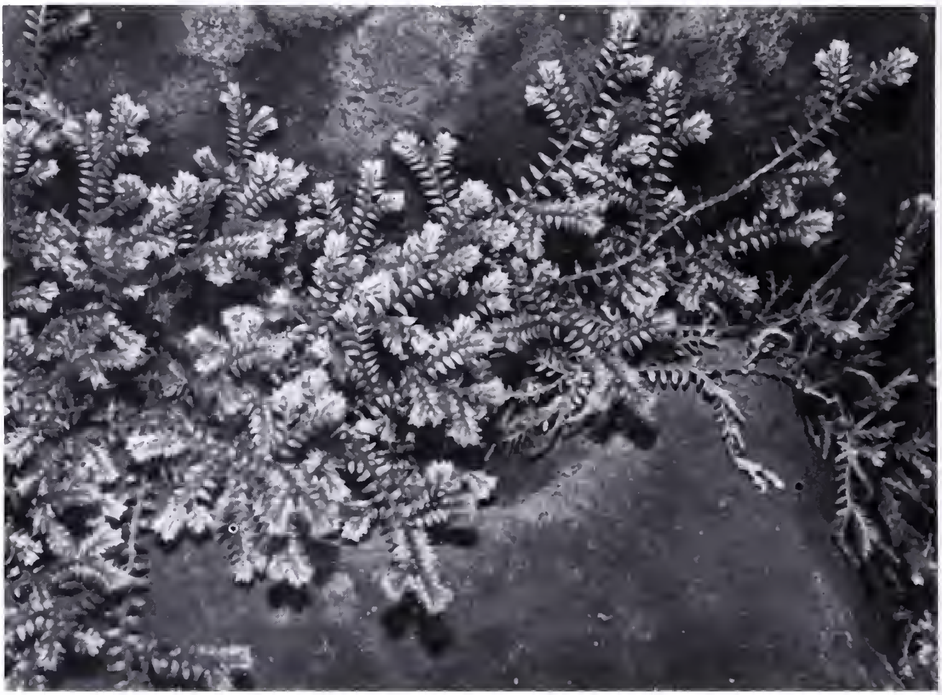
Above: This is *Pilea cadierei* 'Minima', a form not as rampant as the species and therefore more suitable for terrariums. Pinching off tip growth results in a freely branching habit. This form is readily available commercially. Often called aluminum plant. **Left:** *Pilea depressa* has small leaves, shiny and succulent, and is somewhat similar in habit to baby's-tears (*Helxine soleirolii*)—so similar, in fact, that it is commonly found mislabelled as *Helxine* in stores.

Right: *Pilea microphylla,* known as artillery plant, is small and dainty with a fern-like habit of growth. **Below:** *Pilea repens,* called black leaf panamiga, is compact, spreading and has bronze-green textured leaves. It is also free flowering and although the flowers are inconspicuous, they require no effort from the grower and so are a pleasant "plus."



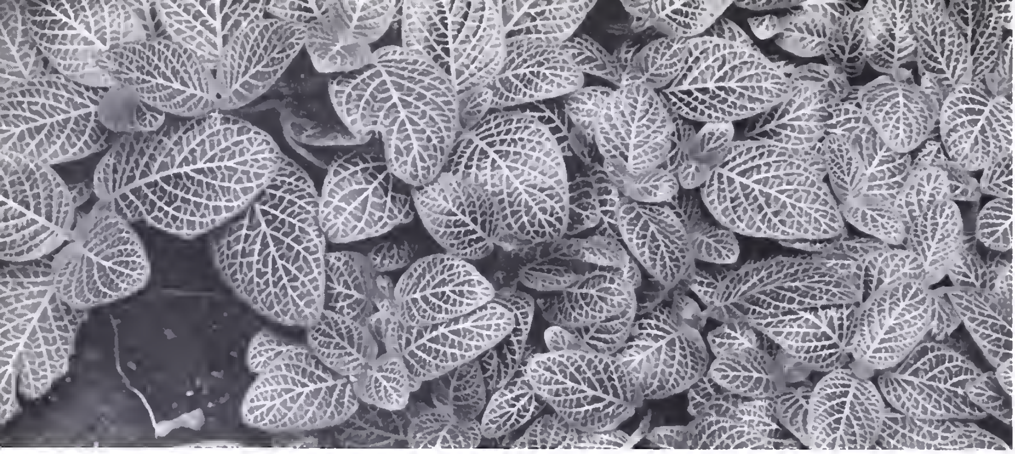
Above: *Adiantum tenerum* 'Wrightii' is one of my favorite ferns for terrariums. It remains quite compact when enclosed but it occasionally will produce a long frond which can be cut off.
Left: *Pteris ensiformis* 'Victoriae', the Victorian brake fern, is another of my favorites. It remains small for a long time and seems to adapt to the size of the terrarium. If a tall frond suddenly appears, cut it off.

Above: Assorted *Cryptanthus* species. In the center is *Cryptanthus* 'Pink Starlight'. Terrestrial bromeliads provide textural interest and are easy to grow, but do not tolerate sogginess. Add fir bark to soil mixture when planting them. **Right:** *Pellionia daveauana* is a spreading plant with variegated foliage. It is especially effective over a rock or piece of wood. Pinch back as necessary.



Above: What would a terrarium be without *Selaginella?* It is indispensable for draping over rocks or bark in the terrarium landscape. **Left:** Another "must" for the terrarium is *Helxine soleirolii,* the familiar baby's-tears. It does require pruning to keep it within bounds.

Right: *Reineckia carnea* is a superb plant in large terrariums or in bottles. It seems to grow more slowly in a closed container than in a pot; also its leaves are not as elongated. Although excellent in cooler parts of the house, it does well in average room-temperature terrariums. **Below:** A variety of the well-known prayer plant, *Maranta leuconeura kerchoveana,* is well suited to the small terrarium.



Above: *Fittonia verschaffeltii argyroneura* has white-veined leaves rather than the red-veined foliage of the species and is considered more satisfactory for terrariums. It must have warmth and high humidity—the last requirement easily met in terrarium culture. This fittonia may be rampant, but is readily pruned. A dwarf form is now available. Fittonia is sometimes called nerve plant.

Left: *Peperomia orba* 'Princess Astrid' makes compact growth and is freely branching when cut back. This peperomia, along with *P. rotundifolia* and *P. rubella*, are the most satisfactory of the genus in a terrarium.

Left: *Podocarpus macrophyllus*, sometimes called yew podocarpus—it is a close relative to the true yew. Young plants grow slowly in a terrarium or bottle, but eventually outgrow their confined quarters and can be potted and grown as house plants.

A natural combination . . .

FERNS AND TERRARIUMS GO TOGETHER

F. Gordon Foster

FERNS, IN GENERAL, are moisture-loving plants and readily adapt themselves to the confined life of a terrarium. With proper selection, the terrarium is not only an object of beauty but it can be one of the most carefree plantings of all household horticulture.

Terrariums are not new in concept but have probably evolved from the practical glass-covered boxes used by Nathaniel Bagshaw Ward during the early 19th century. These moisture-tight containers were the answer to the problem of preserving plant life during long, slow voyages of sailing vessels.

Our present love of terrariums has had its origin in the so-called Wardian case that was extremely popular in England during the Victorian period. At first, these glass boxes were of the most simple construction. Later they developed into more sophisticated cases of leaded glass, ultimately reaching cathedral-like patterns mounted on furniture bases of period design.

Ferns may be used alone in a terrarium or in association with other woodland plants. Avoid unnatural combinations such as a rain-forest fern with some desert cacti, since these plants represent extremes in moisture requirements.

Terrarium styles, both shape and size, are many; dominating are fish bowls and rectangular tanks, brandy sniffers, and plastic dome-covered bowls. Success may be had with a completely closed system or an open-top container. For ease of arrangement, beauty, and freedom from care, my choice is the plastic dome-covered bowl.

Preparation for the fern terrarium in general follows conventional practice for all table gardens. Use an inch of coarse aquarium gravel or equivalent to serve as a moisture reservoir and to keep roots away from water-soaked soil. A layer of crushed charcoal, of the hardwood variety, is good. Do not use crushed fireplace bricquets.

For a growing medium I avoid using topsoil, but rather mix peat moss, perlite and hyper-humus in approximately equal amounts. To this, a sprinkling of bone meal or blood meal is added. For those desiring a commercial product, African-violet ready-mixed soil will do nicely. Tamp the soil lightly but do not pack. At this time, dampen the soil by lightly sprinkling or spraying with water.

Build miniature hills and valleys in the newly spread growing medium. For decoration, add rockwork of cavity-filled, weathered stones or chunks of lava rock. A piece of bark or small branch will help provide a woodland setting. Small bridges, pagodas and "stone lanterns" of pottery, with an occasional frog or turtle, can add to the interest if your taste runs in this direction.

Some ferns are fast growers when given ideal conditions. For maximum beauty, allow plenty of space between plants. What appears sparse in planting can quickly become a jungle.

Ferns that are removed from damp pots may be transferred to the moist terrarium soil with no further watering for a while. Do not apply any supplementary fertilizers and, when water is required, add it sparingly. Overwatering can induce root rotting and cause excessive condensation on the cool glass walls. A nominal amount of condensation on the inner surface of the glass is normal, especially when the room is cool at night or early morning. Lessen excessive moisture by occasionally removing the cover or opening the ventilator. I have had a tightly sealed "cracker jar" terrarium that did well for more than two years without ad-

Photographs by F. Gordon Foster

Above: Terrarium in preparation showing layout of bowl and materials selected—plants, soil mix, gravel, charcoal, stone, pagoda, and tools. **Left:** Finished terrarium, an open bowl with a group of small ferns arranged with a pagoda in an Oriental landscape.

A 6-gallon aquarium tank has been used as an exotic fern terrarium with an arrangement of eight different ferns: Rabbit's foot fern (*Polypodium aureum*); *P. crassifolium;* strawberry fern (*Hemionitis palmatum*); stove brake (*Pteris multifida*); button fern (*Pellaea rotundifolia*); New Zealand mother-fern (*Asplenium bulbiferum*): bird's-nest fern (*A. nidus*); and southern maidenhair fern (*Adiantum capillus-veneris*).

ditional watering. Growth in that case became so dense that a fresh start was the only answer.

Light from a northern window will be ample. Terrariums used in dark areas should have supplementary artificial light. Fluorescent lamps are excellent and are both cool and inexpensive to operate. I have had success with both horticultural-type lamps and "cool white" lamps, used for a 14-hour daily growing period.

I have tried small plants of just about every species of house fern for the terrariums, and find that all may be used for at least a year. My best source has been my spore-growing bank where ferns from ½ to 3 inches are plentiful. Young rabbit's-foot ferns, even when only 2 inches high, are attractive with their white, fuzzy feet. New Zealand mother-ferns often bear "babies" on their leaves when only 3 inches high. Stove brakes (*Pteris cretica*), which volunteer freely, make nice "filler" specimens and tiny bird's-nest ferns around the rocks complete a most natural setting.

For people depending on commercial sources for ferns, I suggest visiting a local greenhouse specializing in ferns and tropical plants, if it is at all possible. Purchase the juvenile sporophytes, or young plants, in 2-inch pots and carefully replant them in the terrarium. Here are a few well-known and available species:

Bird's-nest fern
(*Asplenium nidus*)
New Zealand mother-fern
(*Asplenium bulbiferum*)
Button fern
(*Pellaea rotundifolia*)
False holly-fern
(*Pellaea viridis*)
Japanese holly-fern
(*Cyrtomium falcatum*)
Rabbit's-foot fern
(*Polypodium aureum*)
Mediterranean brake
(*Pteris cretica*)
Venus maidenhair fern
(*Adiantum capillus-veneris*)
Tsus-sima holly-fern
(*Polystichum tsus-simense*)

While the native maidenhair spleenwort (*Asplenium trichomanes*), ebony spleenwort (*A. platyneuron*) and the walking fern (*Camptosorus rhizophyllus*) have been used in the past, it must be remembered that these are endangered species and are disappearing very rapidly. There are a very ample number of fern candidates for the terrarium without resorting to vanishing kinds.

MAKING A TERRARIUM FROM ACRYLIC AND WOOD

Jack Kramer

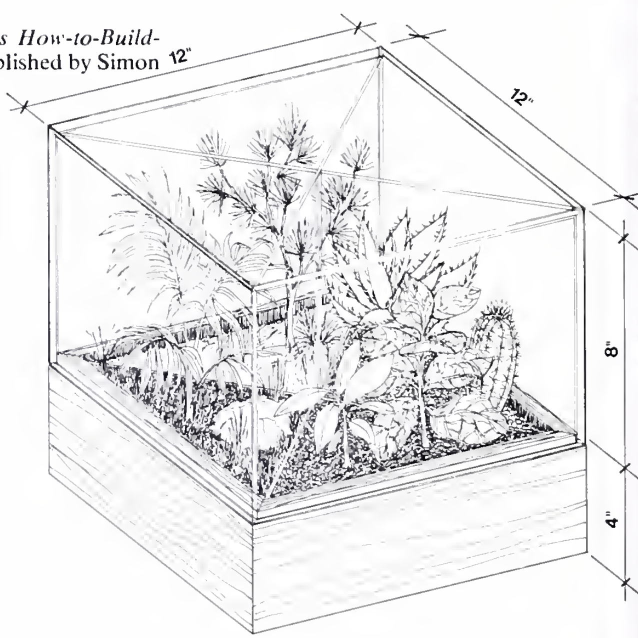
A VARIATION OF the rectangular terrarium is the compartmented design. Use four pieces of flat acrylic crisscrossed, with four sides to enclose the case. After the unit is cemented, construct a suitable base of redwood. Here, too, as in the pedestal terrarium, you might want to insert a galvanized tray into the wood base.

The rectangular and cube terrariums take some time to make, but cylindrical ones can be assembled in 10 minutes. Buy the ¼-inch tubes precut to size, and use disks for bottom and top. All you do for this terrarium is cement one disk to the bottom and set the other disk on top, and you are ready to plant. And if you grow tired of the terrarium, you can always disassemble it, turn the tube upside down, and use it as a plant pedestal. Versatility is one of the wonders of acrylic!

When we think of terrariums we naturally think of them in a vertical position, but with acrylic tubes it is quite easy to make a horizontal greenery, too—and these are distinctive pieces. You cannot find anything like them at stores. Simply cement half disks to each end of a tube, and then place the terrarium horizontally on a wooden base (sold at hobby shops),

(Text continued on page 28)

From *The Indoor Gardener's How-to-Build-It Book* by Jack Kramer, published by Simon and Schuster, New York.

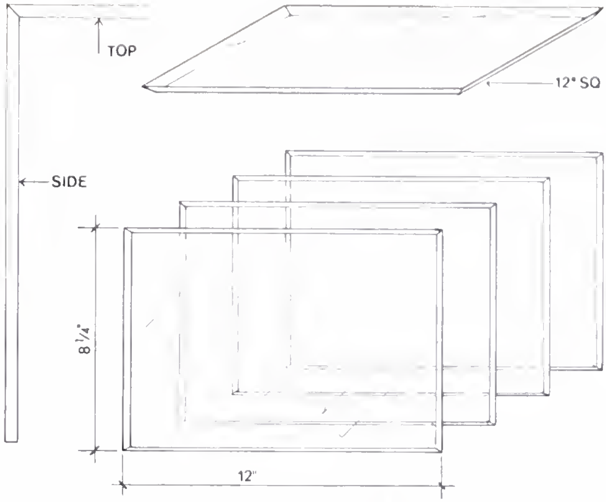


MATERIALS

COVER TOP & SIDES: 1/4" ACRYLIC SHEET, MITERED JOINTS, REMOVABLE TOP
DIAGONAL DIVIDERS: 1/8" ACRYLIC SHEET, LAP-JOINTED AT CENTER, FIXED TO BOTTOM
BASE SIDES: 3/4" WOOD, WATERPROOFED, MITERED JOINTS, TOP EDGE RABBETED FOR COVER
BASE BOTTOM: 1/2" EXTERIOR PLYWOOD DADOED INTO SIDES
NOTE: DIVISIONS ALLOW FOR FOUR "CLIMATIC" PLANT ENVIRONMENTS

COVER TOP

12" X 12" X 1/4" ACRYLIC
ALL EDGES BEVELED 45°



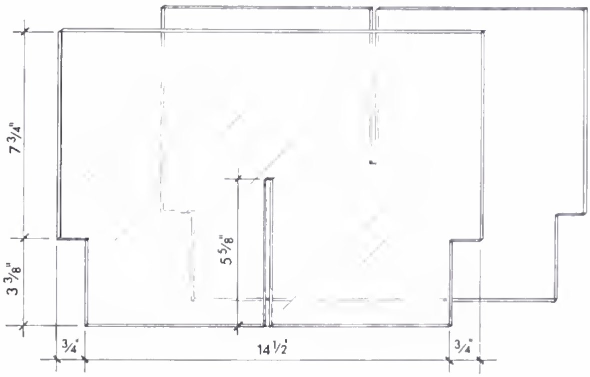
SIDES

4 - 8 1/4" X 12" X 1/4" ACRYLIC
TOP & SIDE EDGES BEVELED 45°

USE A SOLVENT CEMENT TO GLUE SIDES
& TOP AT BEVELED EDGES

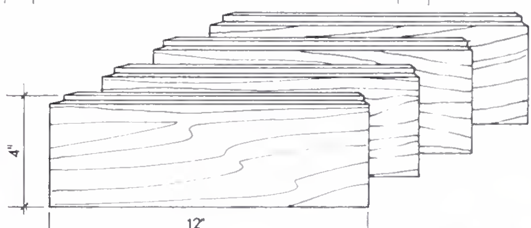
DIAGONAL DIVIDERS

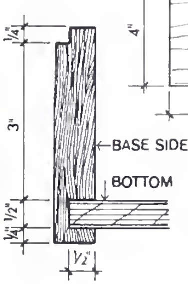
2 - 11 1/8" X 16" X 1/8" ACRYLIC
NOTCHED TO FIT AT BASE
/8" X 5 5/8" LAP JOINTS ON CENTER
AFFIX DIVIDERS TO BOTTOM



BASE SIDES

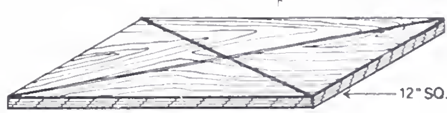
 -12" X 4" X 3/4" WATERPROOFED WOOD
5° MITERED ENDS, 1/4" RABBETED TOP
DGES, 1/2" DADOED BOTTOM EDGE
SE FINISHING NAILS, GLUE





BOTTOM

1 1/2" SQ. X 1/2" EXTERIOR
LYWOOD, 1/8" GROOVES
OR DIVIDERS



DRAWING: ADRIAN MARTINEZ

crylic & Wood Terrarium Construction

MATERIALS

USE CLEAR $\frac{1}{4}$" ACRYLIC

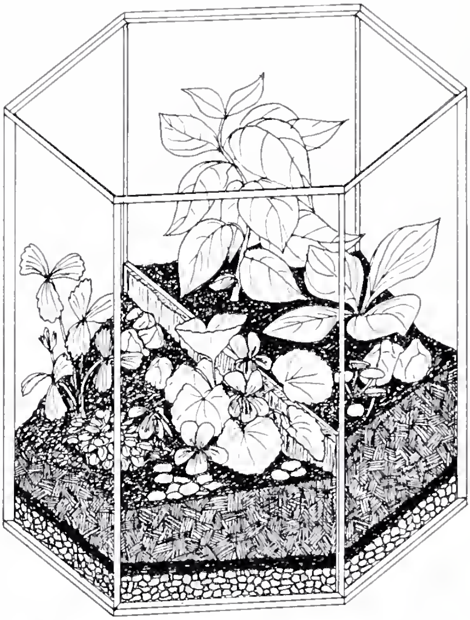
TOP: HEXAGONAL, 9" EACH SIDE, POLISHED EDGES

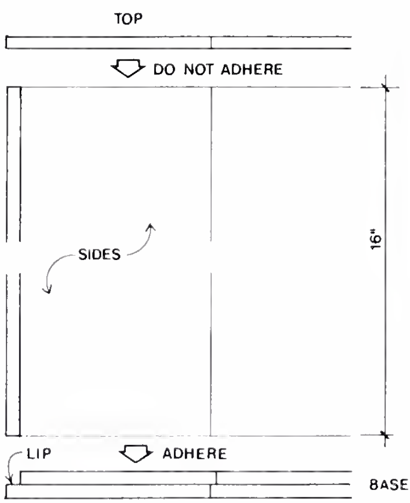
SIDES: 6 at 9" x 16", SIDE EDGES BEVELED 30°, TOP EDGE POLISHED

DIVIDER: 6" x 17", SLIPPED IN DIAGONALLY

BASE: 2 HEXAGONS, ONE 9" THE OTHER $8\frac{5}{8}$" EACH SIDE, ADHERED FORMING A LIP FOR THE BOTTOM EDGE OF SIDES

NOTE: USE A SOLVENT CEMENT TO GLUE SIDES TOGETHER & TO BASE





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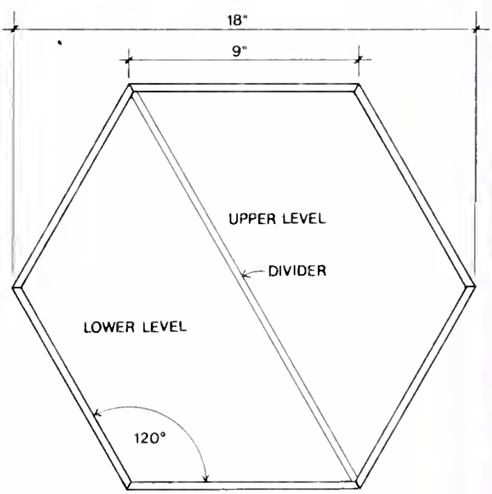
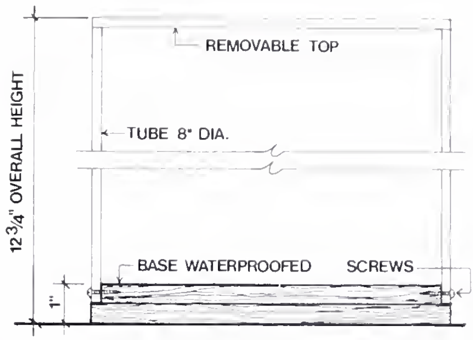


PLAN

Hexagonal Terrarium

DRAWING: ADRIAN MARTINEZ

VERTICAL TERRARIUM

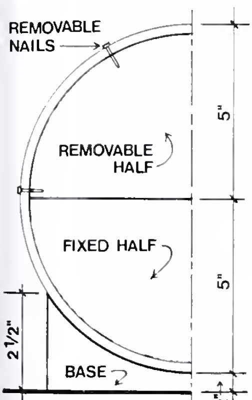


DETAIL

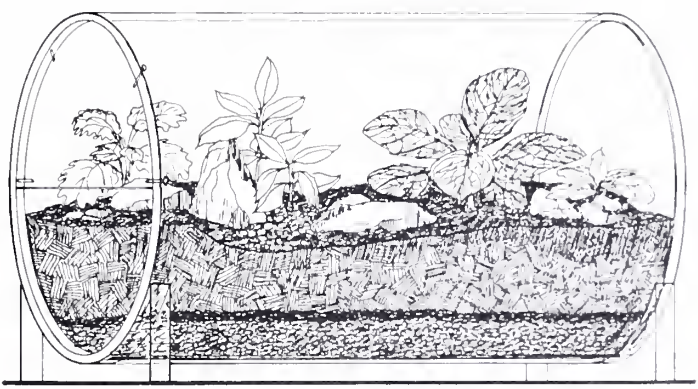
MATERIALS

VERTICAL TERRARIUM
TOP: 8" DIA. x 1/4" ACRYLIC DISK
SIDES: 8" DIA. x 12" HIGH x 1/4" ACRYLIC TUBE
BASE: 7 1/2" & 8" DIA. x 1/2" REDWOOD DISKS ADHERED TO EACH OTHER TO FORM A LIP FOR THE TUBE, ATTACH W/SCREWS

HORIZONTAL TERRARIUM
SIDES: 10" DIA. x 16" LONG x 1/4" ACRYLIC TUBE
BASE: 2 - 2 1/2" x 8" x 1/2" ACRYLIC PIECES W/CUTOUTS FOR TUBE TO SIT ON, ADHERED AT ENDS
ENDS: 2 - 9 1/2" DIA. x 1/4" ACRYLIC DISKS (1 CUT IN HALF) ONLY THE UPPER HALF DISK AT ONE END IS TO BE REMOVABLE & HELD IN PLACE W 1/2" NAILS IN PRE-DRILLED HOLES



DETAIL



HORIZONTAL TERRARIUM

Acrylic Tube Terrariums

DRAWING: ADRIAN MARTINEZ

or, simpler yet, find a suitable long dish, fill it with sand, and merely place the terrarium in position.

You can also try hexagonal terrariums, with six panels cemented together. However, end cuts must be chamfered so panels butt together flush when they are cemented. Precision is absolutely necessary when assembling this unit, so tackle it only after you have become somewhat experienced in working with acrylic. (See drawing page 26.)

Terrariums in the Air

Hanging plants are popular and so are hanging terrariums. They are excellent decorative accents, and it takes only a few minutes to prepare a hanging planter. Simply drill four holes, one in each corner of the cube or rectangular terrarium and suspend it with hooks and wire from the ceiling.

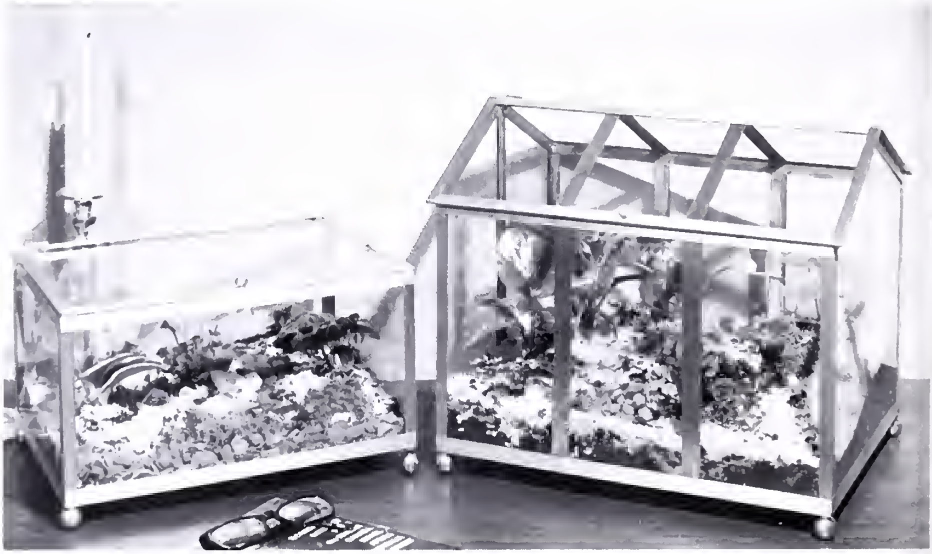
The cylindrical terrarium can be treated the same way, and I have found that you can even sidestep the hole-drilling in the horizontal cylindrical greenery by passing a 2-inch-diameter acrylic rod through the cylinder and then suspending the rod on suitable supports. Use eye hooks for drilled holes and monofilament wire from the hooks to support the garden. Use a heavy eye bolt in the ceiling.

You can also elevate desk and table terrariums on acrylic or wooden stands. Besides lifting the garden off the table surface and preventing water stains, the stand puts the case in a better position to be seen and appreciated.

Miniature Greenhouses

These units are available commercially, but it is so easy to make your own and so much cheaper. Simply construct a box design; take the rectangular terrarium and put a roof on it. This will mean two more pieces of acrylic for the eaves and two triangles to complete the greenhouse. In this greenery you can grow almost any kind of plant you want, and you can also propagate plants because of the fine humidity inside.

The acrylic greenhouse is delightful in small sizes on a table or desk, and, as I have recently seen, it is becoming increasingly popular in much larger sizes outdoors.



M & G Sheet Metal Co., Inc.

The miniature greenhouse terrarium can be purchased (*right*) or can be constructed by adding a roof to a rectangular terrarium made of acrylic. The miniature greenhouse above is 17 × 14½ × 12 inches, a convenient size for a table or desk.

A giant step toward foolproof maintenance

POTS IN TERRARIUMS

Virginie F. and George A. Elbert

As long as the tradition persisted that a terrarium was a transparent container in which small evergreen plants of the forest floor were arranged in a naturalistic setting, it was altogether logical to set them directly into soil. This was gathered from the area in which the plants grew in order to reproduce natural conditions as closely as possible. In the case of the northern United States, it was a very acid soil to suit woodland plants such as wintergreen, partridge-berry, pipsissewa, rattlesnake-plantain, ferns, lycopodiums, selaginellas and mosses, which all lived together and grew very slowly.

The Woodland Terrarium

The traditional terrariums required cool conditions and were kept in situations where they were protected from summer heat. For this reason, among others, they did far better in the country than the city. And they were all "daylight" terrariums which thrived in reflected light much like that which the plants were accustomed to receiving under the shading of forest trees.

No doubt there will continue to be many devotees of this kind of terrarium —which can be both charming and durable. But lately the objection has arisen that the plants which are used are removed *from the wild* and contribute to that progressive destruction of the natural environment about which we are so much concerned. The damage may be very small in each instance, but the popularity of these terrariums has been considerable and the total of plants used for the purpose is not insignificant.

Fortunately an entirely new approach to terrarium planting has come about. It is the result of the recent influx of tropical plants and their hybridization—a source of plant material of great variety which was not available even a few years ago. This inundation of new plants has gone hand-in-hand with technological advances such as more even year-round house temperatures, and the use of fluorescent lights, such as the Verilux Tru-Bloom tubes, for growth and bloom. Not everybody could maintain the old-fashioned terrariums because they required space near windows and were very sensitive to damage from over-heating. The modern indoor environment increases the difficulty of maintaining the old ways while creating ideal conditions for the new kind of terrarium.

A New Kind of Terrarium

The changes are great. We no longer use unsterilized soils, and acid ones are incompatible with most tropical house plants. Instead, we have sterile soilless mixes, consisting of peat moss, vermiculite and perlite. The new plants also behave differently. They flourish in warmth and high humidity. Instead of constant greenery there can be flowers over a long period. In fact, the bloom can be year round. This is no idle claim because we have had terrariums in which plants flowered continuously for as many as three years without missing a day. All that prevented some of them from continuing was the fact that, though quite slow growers, they finally overran the space allotted to them.

Of course we continue to use foliage plants. But here, too, the repertory has changed. Our selaginellas and other creepers are of tropical origin and far more varied and beautiful. There are a number of attractive upright ornamental leafy plants available just for terrarium growing and which could not possibly

All photographs by George A. Elbert

Circular terrarium before potted plants have been placed. Plastic pots, as small as possible, are preferred because they take up less space. The soilless mix and strategically arranged rocks serve to hide the pots. Small pots help to confine roots and restrict growth.

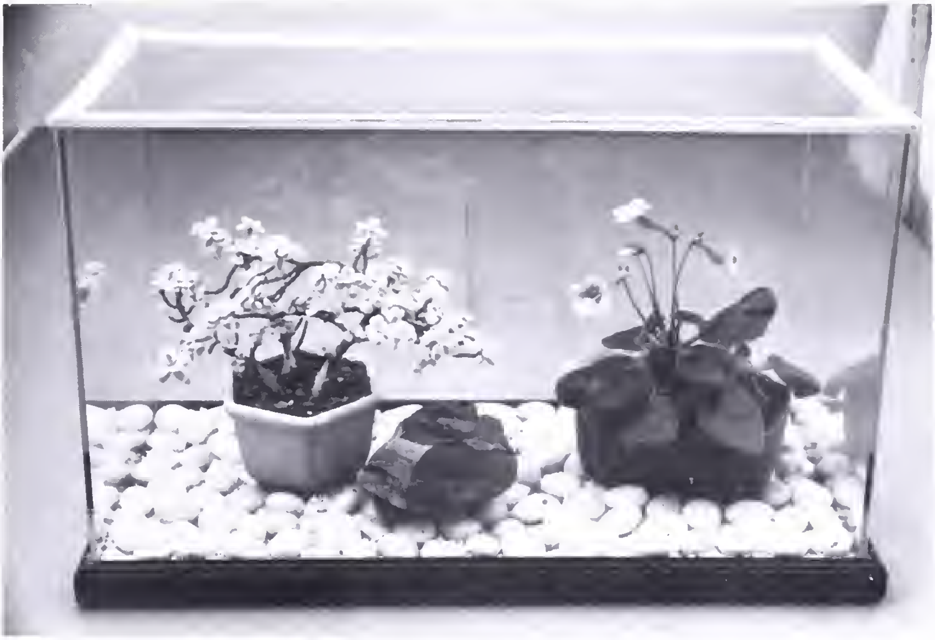
exist in the same environment as the old northern woods plants.

While working with this type of plant material, we soon came to the conclusion that setting it directly into the soil no longer made sense. Even with the old type of terrarium it was something of a disaster if a plant spread beyond its space, became diseased or died. Its removal disrupted the whole arrangement. In a terrarium roots tend to be shallow and to spread horizontally. It is impossible to dig up a plant without partially uprooting others and knocking out of position structural features such as stones or pieces of wood on which the "scene" is built. In a tropical terrarium roots spread more rapidly and the risk of damage is even greater.

For these reasons we decided to experiment with the use of pots in terrarium plantings. The results were a vast improvement in growth, in appearance, and in ease of handling. The method has proved ideal with all the little gesneriads, begonias, orchids and tropical creepers of which there is now such a rich repertory. We found no difficulty from the first in burying the pots so that they would be invisible. We soon discovered that the angle of plants could be controlled—plants made to slant forward or toward the center of interest in the terrarium landscape. We could use different mix formulas for different plants and control the amount of moisture and fertilizer when these were needed. Because of the pots it was possible to maintain much more colorful and varied arrangements. However ingenious in workmanship, the old woodland terrariums were always very much alike. Now, by means of pots, we could be far more inventive and design over the full gamut from the naturalistic to the most abstract arrangements. Terrarium planting became much more of a craft and gave greater freedom to the imagination. (For further details see our book, *Fun with Terrarium Gardening.*)

Application of the method is simple. We like plastic pots in terrariums because the walls are thinner and take up less room. Special drainage material is never employed in the bottom of the pot because soilless mixes drain perfectly, and we need the space. However, a piece of plastic screening is placed over the bottom of the pot to prevent roots from growing into the surrounding medium. By choosing the smallest pot which will fit a plant we confine its roots and stunt its growth —which is just what we want. Of course this is unnecessary with the miniature kinds of *Sinningia* which have small root systems.

In building a "landscape" we pile the



A different kind of terrarium garden—plants in ceramic bonsai pots arranged to show their own formal beauty. The effect is of an abstract garden on a miniature scale.

soilless mix in a terraced arrangement with peaks. Terraces are not made all on one level or any flatness allowed unless it is relieved by large objects such as stones. Level terraces are like shelving. So we seek the sharpest contrasts in height possible within the confines of the container. That also provides the greatest number of planting areas.

A hole is dug for each pot and the pot is then "planted." If it is in a shallow part of the terrarium strategically placed stones will cover a projecting rim. Since there is no worry about root disturbance in planting we don't have to tolerate inexact placement. The pots can be shifted around at will until they are just where we want them. If a plant is unsuitable, it can easily be changed. We have complete freedom in manipulating the terrarium environment.

The use of planted pots led to another interesting development in terrarium design. The rectangular containers make beautiful showcases and the terrarium environment suits many tropical and succulent plants we might not wish to use in a permanent arrangement. If, instead of plain plastic pots we chose small, exquisite ceramic kinds—for instance, ones with simple but elegant Japanese designs—and selected plants not for their naturalness in a landscape but for their own formal beauty, there could be an entirely different kind of terrarium garden—something, as a matter of fact, very close to the Japanese concept of an abstract garden on a miniature scale.

By covering the bottom of the terrarium with pebbles, sand or other textured material and using mineral specimens, shells or wood fragments as accents, we can build a setting for one or more potted plants and have a very decorative design. With a little practice they are made almost effortlessly, the scene can be shifted at will in a moment, and the plants are in a trouble-free environment needing little attention.

Modern terrariums can be left untouched for weeks. However, as we become more dependent on fluorescent light for maintaining them, one precaution must be mentioned. Terrariums grown under lights are far less susceptible to overheating than ones exposed to various degrees of natural sunlight, but there is still a risk of this occurring on warm summer days. To minimize the hazard, a small space for ventilation should be left and the medium within the container allowed to dry out to some extent. This means that plants must be watched more closely and water applied lightly but directly into the surrounding medium at regular intervals, especially in summer—but usually no more than every three or four weeks. Watering should be very judicious, since the secret of terrarium maintenance involves the right amount of soil moisture and no excess.

There is an additional point to remember. If you do remove a healthy plant and its pot from a terrarium after it has lived there for a while and become accustomed to the environment, always cover it with a plastic bag and harden it off slowly before full exposure to the outer atmosphere. The way to do this is to gradually let in more and more air before placing on an exposed shelf.

It won't be long before everybody will be using pots in terrariums. Besides the obvious advantages there may be a side benefit because the practice should encourage indoor gardeners to space their plants more widely to allow for growth. Best of all, it may put a stop to planting terrariums, especially commercial ones, which look like tossed salad greens and become choked with greenery in a month.

A terrarium of potted plants. An advantage to using potted plants is that overgrown plants can be easily removed without disrupting the other plants. And of course potted plants do not grow as rampantly.

Above: A desert garden of various kinds of cacti and succulents—all in pots. **Below:** A terrarium landscape, Japanese in its mood, before the placement of potted plants.

A terrarium environment can duplicate the bog conditions these plants need

INSECTIVOROUS PLANTS INDOORS

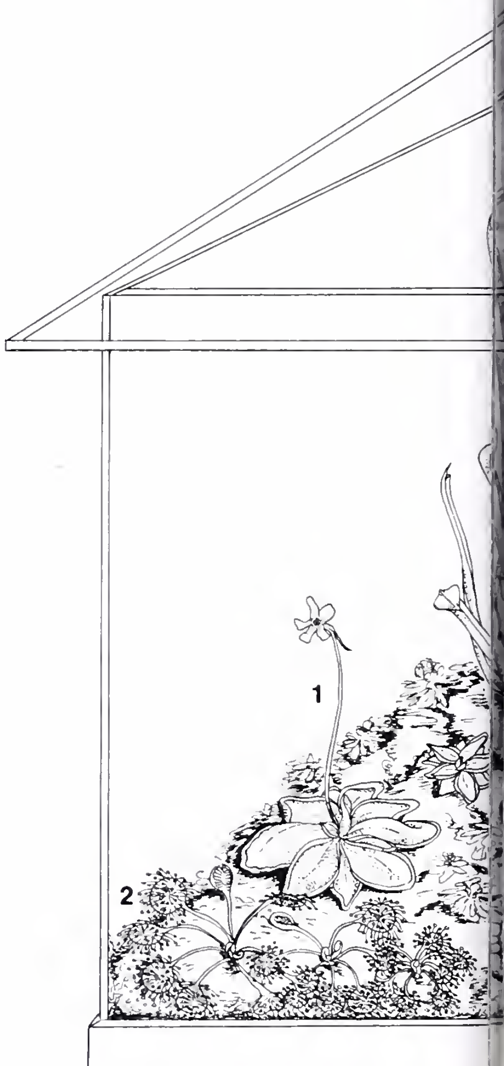
Stephen K-M. Tim

IF ONE were to pit the eye-catching value of, say, a coleus against a squirrel, it is simple to guess in which direction the majority of eyes would turn. Doubtless, the antics of the animal, associated with movement, would capture the imagination of most people.

Perhaps this is why the insectivorous plants stand out in the plant kingdom. Horror stories woven around their almost animal-like characteristics have led many people to believe that these plants inhabiting the dank, tropical jungles are huge, cunning and all too eager to wrap ever-flailing tentacles around unsuspecting victims to satisfy their insatiable appetites for raw meat.

Such vicious plants do not exist, much to the disappointment of the young folk who eagerly inquire when visiting a lush greenhouse: "Where are the man-eaters?" Nevertheless, quite aside from the sensational—insectivorous plants are fascinating and a selection of these plants can be introduced into the home. There they will certainly rank among the foremost of conversation pieces.

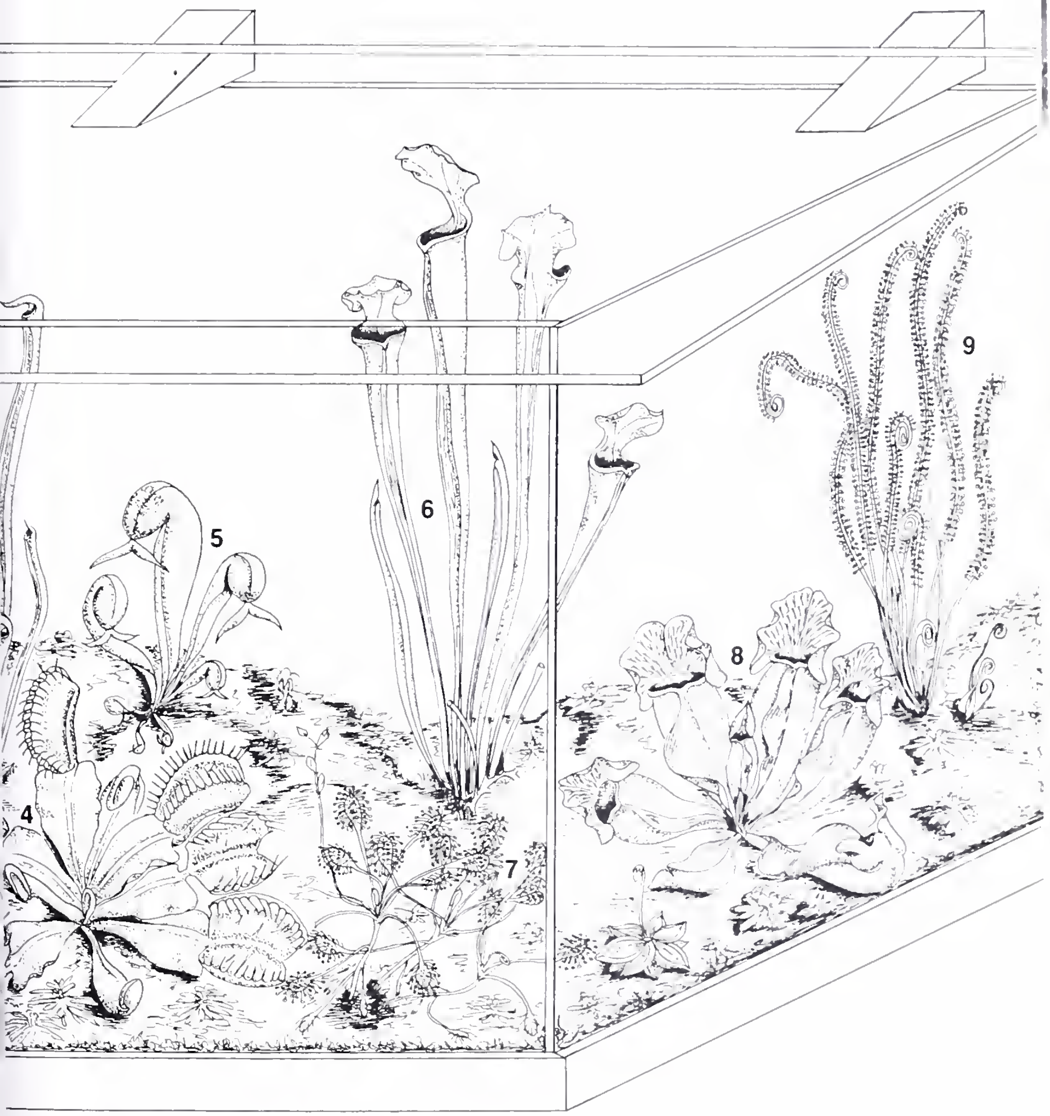
Their requirement for good lighting,



Planted terrarium of Insectivorous Plants

1. Butterwort (*Pinguicula caudata*)
2. Sundew (*Drosera rotundifolia*)
3. Miniature Huntsman's Horn (*Sarracenia rubra*)
4. Venus Flytrap (*Dionaea muscipula*)
5. Cobra-lily (*Darlingtonia californica*)
6. Huntsman's Horn (*Sarracenia flava*)
7. Sundew (*Drosera intermedia*)
8. Northern Pitcher Plant (*Sarracenia purpurea*)
9. Threadleaf Sundew (*Drosera filiformis*)

Stephen K-M. Tim



Brenda Weisman

Venus Flytrap in bloom. The traps are expanded ends of the leaves.

coupled with high humidity, make these plants ideal terrarium subjects. It is usually the combination of dry room conditions with an unsuitable growing medium that has discouraged so many who have attempted growing insectivorous plants outside a terrarium.

To appreciate fully their cultural requirements, consider some of the biological factors that endow these plants with such unique characteristics. The majority of insectivorous plants grow in bogs and certain wetlands where the growing medium is very acidic. Under these conditions, various mineral elements associated with good growth, such as nitrogen, phosphorus, potassium, magnesium and calcium, are not readily available. While these plants do contain chlorophyll, a deficiency in some of these elements interferes with the process of photosynthesis. It appears that at least a portion of these essential elements becomes available to these plants as a result of the breakdown of animal tissue, primarily the protein. It is difficult to become blasé about the marvellous adaptation of this unique group of plants to a specific habitat. "Plants that eat insects," a phrase often used to describe these wonders of nature, really conveys the wrong impression; plants do not, in the British expression, "up, and gobble down their grub." However, the comparisons with human traits that accompany insectivorous plant descriptions are difficult to overcome.

In the Home

Try to simulate the conditions found in the bogs by providing a suitable growing medium and maintaining high humidity around the plants. For this, a terrarium, an "insect terrarium" in fact, is excellent.

As regards the size of the terrarium, avoid very small containers. Some plants come pre-packed in tiny plastic cases and the fluctuation in temperature in these can be extreme; even a short bout of sunlight can prove detrimental to such plants.

If you start with a collection of about six to eight plants, the most suitable container is a fish tank, approximately 12 by 18 inches by 12 inches (or more) in height. Some specially constructed terrariums are higher and will accommodate the taller forms such as *Sarracenia flava,* more easily. One need not only think of a selection of plants. A single fish-bowl terrarium (about 8 inches diameter) housing two or three Venus flytraps can be just as intriguing.

First, line the base of the container with an inch-deep layer of clean, coarse bird gravel (⅛-inch grit size or larger). On top of this add:

- 3 parts coarse (unmilled) sphagnum moss. This is usually sold dried. If the moss has been only recently dried, it may start growing and green up again. If not, some live sphagnum (obtainable from insectivorous plant

Pitcher plants in the Peter Pauls Nurseries which specializes in insectivorous plants.

dealers or occasionally, florists, or you may know of a bog where sphagnum grows naturally) can be tucked into the surface of the mixture and it will soon spread and form a carpet of luxuriant green growth.

- 1½ parts coarse perlite
- 1 part builder's sand (optional)

Some growers prefer to use pure sphagnum. This is acceptable, provided that the moss is very coarse and preferably living. The dried sphagnum does tend to break down with time; the perlite is there to keep the moss from compacting. If the moss is bone dry, soak it in a bucket, kneading and stirring the moss with your hands until thoroughly wet. Mix the ingredients well. Plants may be grown directly in the medium or first planted in pots (plastic or clay) and in turn submerged in the medium. The latter method is preferable because the individual plants can be tended more easily and rearranged when desired. Whatever the case, the medium should be contoured interestingly over the bird gravel with high areas (4 inches or so) toward the rear and the lower ones (about 1½ inches) toward the front. A series of artistically placed hummocks provides a pleasing landscape—or bogscape.

Plants for Terrariums

Pitcher Plants *Sarracenia minor, S. psittacina, S. rubra, S. flava* and *S. purpurea*

The pitcher-like leaves forming the traps are open at the top and are filled with water. Insects, lured by the nectaries on the sides and mouth of the pitcher, find their way into the pitcher and their escape is hindered by downwardly pointing hairs, especially around the mouth of the trap. Digestion is carried out by the action of digestive juices (enzymes) secreted by glands on the inside of the pitchers. Bacteria are also present in the water and aid in the breakdown of the insect. In this way, valuable nutrients are made available for absorption by the plant.

Peter Pauls Nursery
A group of sundew plants in a terrarium.

Venus Flytrap *Dionaea muscipula*

This is the one plant that manages to capture the imagination of most young people when they are first introduced to it, usually in some children's encyclopedia. It is touching to see a child's face light up when he or she beholds the living flytrap for the first time; here is one of those few plants that is unfailingly recognizable from drawings. The traps consist of the expanded ends of the leaves, hinged down the center and with long, teeth-like projections on the edges. An insect, setting off the trigger hairs on the insides of the leaves, causes the two halves to snap shut over itself. Juices are produced from the leaf and serve to digest the soft parts of the insect. The more resistant parts remain untouched and are present on the traps when these open again after about ten days, ready for the next meal.

Sundews *Drosera rotundifolia, D. intermedia, D. filiformis*

These are like jewels when the beads of viscid substance on the leaf tentacles glint and sparkle in the light. The sticky substance on the tentacles prevents the escape of the tiny prey (an ant, for example) and the more the prey struggles, the more it becomes enmeshed among the tentacles. These gradually bend over and touch the insect and the leaf itself may curve over to envelop it further. If live sphagnum is used, the moss must be trimmed occasionally to prevent it from surrounding and smothering the delicate sundews.

Butterworts *Pinguicula pumila, P. lutea, P. vulgaris, P. caudata*

The neat rosette-like formation of bright green leaves make these very attractive plants. Their flowers are also most inviting, and well-grown specimens seem more suitably placed among the alpine rock plants than in a humid terrarium. The leaves are covered in minute glands that secrete a sticky fluid. Very tiny insects fall prey here and the edges of the leaves may respond by partially curling over them.

Cobra-lily *Darlingtonia californica*

Although this plant grows out of character in the terrarium, it is nevertheless most interesting and loses none of its cobra-like appearance. In the wild it may reach a height of 2-3 feet but grown in the terrarium, a number of factors, one of which is the relatively high temperature, result in this plant remaining dwarf. The traps here consist of hollow, pitcher-shaped leaves, the mouth of which is hooded.

Care

All of the plants cited above are adaptable to pot culture. Pot them individually in the sphagnum mixture and sink the pots in the terrarium. As mentioned previously, a few sprigs of live sphagnum tucked in here and there will soon flourish and carpet the whole surface with lush green growth.

Water with a spray bottle but don't let too much settle in the layer of drainage gravel. One refinement here is to have a drainage hole at the base of the terrarium, thus making it possible to flush out the medium with fresh water every couple of months. Such an opening should be covered with fine aluminum mesh to prevent any of the mixture from being washed out. In the event of the local tap water being very hard, use distilled or rain water, but in general, tap water is quite suitable. A sheet of plexiglass over the top will help maintain the high humidity within the terrarium. However, keep it slightly ajar during the warmest part of the day.

Certain plants such as the pitcher plants will benefit from wetter growing conditions. To achieve this, cut a plastic container to size (the plastic margarine containers are ideal), fill with water and stand the potted plant in this. The "saucer" and pot are both buried in the sphagnum-perlite mixture.

Good lighting is essential but avoid letting prolonged, direct sunlight strike the terrarium. This will cause a rapid heat build-up and may damage the plants. A bright east or west window is fine but a spot a few feet away from a southern exposure is ideal. Many forms of the Venus flytrap show a reddening of the inner part of the trap with good light intensity. In fact, some forms take on a rich red coloration. Some of the pitcher plants also produce a red mottling with good light. These effects may be used as indicators of whether or not the light is bright enough.

Some hobbyists have resorted to supplementing the available light with fluorescent lighting. The standard combination of one warm white with one cool white tube has given some good results. However, if the daylight is insufficient or if the plants are grown entirely under artificial light, it appears that tubes providing a wider spectrum of illumination accentuate the red coloration in the plants. Lights should be kept on for 16 to 18 hours per 24 hours.

A day temperature of around 70° is ideal. The average room temperature is usually warmer than this but it is important that the evening temperatures drop somewhat, preferably to about 65°. The plants mentioned here do benefit from a cool rest during the winter and if at all possible, should be moved to a cooler location, such as an unheated sunporch from mid-December to about the end of February. Try to keep the temperatures at 60° or less during this time.

Do not apply fertilizer to the growing medium. However, by all means "feed" the plants the occasional morsel of food. Flies often find their way into the terrarium and provide a useful tidbit for the plants, especially the pitcher plants and Venus flytrap. Otherwise use tiny pellets of lean beef. Whatever the case, do not overfeed. This leads to decay of the traps and even the whole plant. Also, constant "teasing" of the flytraps is not a good practice.

As incongruous as it sounds, insectivorous plants are subject to attack by insects. Early spring growth is preyed upon by aphids and these are best washed off with a jet of water. If need be, use a dilute solution of a mild detergent. With scale and mealy bug attack, remove the potted plants (the advantage of having the plants in individual pots is especially evident when having to deal with insect infestation) and clean off the insects under running water or swab off with rubbing alcohol. A serious infestation may require spraying with malathion but before resorting to this, fashion a collar of waxed paper or plastic around the pot to protect the sphagnum moss. The latter is particularly sensitive to the malathion and will be killed by the spray. The butterworts are also sensitive to the malathion and if they do require this treatment, wash the plants thoroughly under running water about 15 minutes after spraying.

Finally, a plea. The habitats in which these fascinating insectivorous plants are growing are extremely fragile. As it is, housing and other developments have destroyed many acres of bogland, wiping out all traces of the natural vegetation. The insectivorous plants and the sphagnum are the first plants to succumb when the bogs are drained. It is everyone's responsibility to preserve what remains. So please, please do not ravage these areas where insectivorous plants are to be found. Rather collect seed or only remove a very few plants. Even in the case of the sphagnum, take just what you can use, remembering that it grows rampantly under terrarium conditions. There could so easily come a time when certain of these unique plants (the Venus flytrap is a case in point) could disappear from the wild. That will be a very sad day indeed.

The terrarium can be useful for the orchid hobbyist

ORCHIDS IN THE TERRARIUM

Carl L. Withner

MY ORCHID TERRARIUM was arranged and planted 13 years ago and is still in my window. How can one count the satisfactions and pleasures it has provided over the years? To be certain, it has been replanted or rearranged once or twice in that period, and twice has spent the winter in a cold spare bedroom, but otherwise it has survived and has only required watering a few times a year. The enclosure makes it possible to control a difficult environmental factor in the home—humidity; and light can be provided from artificial sources if natural lighting is not sufficient. In the summer a piece of tissue paper is necessary on the back to prevent overheating and sunburn.

The terrarium was set up the same way as I have done with others, all made from old 10- or 20-gallon aquarium tanks. A layer of plastic goes in the bottom to prevent leaks, and upon this an inch or so of coarse gravel or sand is placed. Then sterilized African-violet potting soil from the garden shop was layered and banked 2 to 3 inches deep. A rock, a plant of polypody fern, a clump of clubmoss, a piece of an old stump, and wood moss and live sphagnum to cover the soil completed my composition. The original terrarium included two clumps of the hardy rattlesnake-plantain orchid (*Goodyera pubescens*), with its attractive white-veined leaves.

This planting lasted for a few years. The rattlesnake-plantains flowered, the fern grew and had to be pruned back, and I subsequently learned that the ebony spleenwort fern was as good for this purpose as the polypody. Both were small enough to be accommodated without overgrowing the container. When the sphagnum moss grew too high, I just pushed it down to keep it under control.

The secret of success turned out to be in the watering. Too much, and condensation became a problem resolved by sliding the glass top to one side for a while until the moisture decreased. A little condensation at night on the cool side toward the window was expected, but not enough to drip. Continued excess water permits the growth of blue-green algae that eventually coat the plants and sour the soil. When the orchids flowered and bloomstalks protruded, the cover had to be slid to one side. A little extra water had to be added then, otherwise watering once a month or less was sufficient.

No less important than the amount of water is the kind of water. The chlorine in city water destroys moss and sphagnum, so only use rain water, bottled water, or, best of all, water from your aquarium when it can be spared.

The jewel orchids, or gold lace orchids, with velvety leaves and bronze-gold or red veining are the tropical orchids most at home in a terrarium. When not growing or flowering, there are still beautiful satiny leaves to glisten in the light. Even an old bare, dormant stem will come to life when nestled into a clump of moss—first a furry root, then the magnificent leaves. The spikes of attractive white flowers in the winter last about two weeks. There are various species in the genera *Haemaria*, *Anoectochilus*, *Goodyera*, *Microstylis*, *Erythrodes* and *Macodes*, not easy to find but available here and there, that are most suitable for this terrarium use.

Other orchids that I have tried from time to time have not survived as well as the jewel types grown mostly for their foliage. Other terrestrials have grown for one or two seasons, but the lack of real drying or a complete temperature change to bring about dormancy seems to result eventually in their demise. Epiphytic orchids do not receive enough air under terrarium conditions and are generally not to be recommended for this use. They also produce soft growths susceptible to rotting since the terrarium cannot be exposed to sufficient light without a heat build-up. It is, however, a good way to perk up a dehydrated plant by a short stay of a week or two. A puff of insecticide or fungicide under these closed conditions usually is most effective.

Is it still a terrarium if you leave off the glass on the top of the aquarium? Probably so. With this open terrarium technique the container may be modified to be suitable for epiphytic sorts of orchids, particularly miniature species such as *Pleurothallis*, or seedlings. *Phalaenopsis* seedlings have been grown along, also plants of miniature variegated-leaved lady-slippers. Small orchids attached to tree fern sections may be hung by wires from the rim. To adapt the tank for these purposes, the bottom of the container is covered with peat moss, and the plants are then placed on cake racks above it so the pots do not get too wet. The enclosure, though open, confines the humidity about the plants and makes all the difference in trying to grow them in the home environment. Try it, experiment a little; you'll like the results.

Charles Marden Fitch

A tropical jewel orchid, *Anoectochilus sikkimensis*, growing with *Adiantum hispidulum*, a maidenhair fern. The jewel orchids are terrestrial orchids suited to terrariums.

For flower color in the terrarium . . .

GESNERIADS FOR TERRARIUMS

Frances N. Batcheller

ONE way of making a terrarium possess special interest is to fill it with plants from one family. The gesneriad family is a good choice for such specialization. Many species are native to tropical rain forests and therefore pre-adapted to the conditions of high humidity and low light intensity usually prevailing in most closed containers. Many are epiphytic in nature, clinging to tree bark or pocketed in rock crevices and therefore content with shallow layers of soil. Because gesneriads propagate vegetatively so easily—from tubers, scaly rhizomes, tip cuttings, or even single leaves, it is possible to start a terrarium with unrooted material, making placement easier and eliminating problems of root pests or disease.

Gesneriads suitable for terrariums come in a great variety of sizes and shapes, from symmetrical flat rosettes like miniature sinningias and saintpaulias; to graceful trailers like codonanthes and columneas; to small shrubby plants like gesnerias or bellonias. Some are true miniatures, others can be kept compact by pruning. Some can be grown until they expand beyond their allotted space, then replaced with a new tip cutting from the same plant. Gesneriads provide some of the most rewarding flowering plants available for terrariums. The color range is extensive, both in the flowers and in the decorative foliage.

Gesneriads which form tubers or scaly rhizomes go through a period of dormancy. Most of the small tuberous sinningias used in terrariums are dormant for only a short time, frequently putting up new sprouts before the old crown has begun to show yellowed leaves and needs removal. Plants forming scaly rhizomes like *Koellikeria* and *Phinaea* may rest for longer periods of up to several months before resprouting.

The major problem in using gesneriads in terrariums is not in growing them but in finding a source for all the desirable kinds. Fortunately, more and more house plant shops are beginning to stock some of the unusual ones. There are several commercial growers who specialize in gesneriads and carry a wide variety. One of the best ways to obtain rare plants is to join a plant society devoted to gesneriads so that it is possible to purchase seeds, obtain plants at meetings, or exchange with other members. (See page 82 for addresses.)

The following alphabetical listing gives a few brief notes on some of the gesneriads which are small enough to be suitable for a medium-sized terrarium of up to 2 feet in length. Many gesneriads other than the few listed here could be used in larger containers.

Achimenes. These plants grow from scaly rhizomes and are generally summer blooming in natural light, but may be flowered at other times under fluorescent light. While most achimenes are too rampant for use in terrariums, there are a few which are suitable. *A. cettoana* has an upright growth habit, reaching 8 to 10 inches, with bronze-colored lance-shaped leaves 1½ inches long. The lavender flowers are large in proportion to the plant. It should be grown only in a terrarium that permits easy access to remove the faded flowers, which are produced plentifully. *A.* 'Crimson Tiger' has a low spreading compact habit with smaller, closely spaced leaves. The small flowers are semi-double, resembling a rambler rose, and last 10 days to 2 weeks before fading.

Alloplectus. *A. nummularia (Hypocyrta)* is a fibrous-rooted plant, trailing in habit, with bright red small pouched flowers, marked with a black line around the narrow throat. The oval leaves are 1 inch long. This plant may have occasion-

Charles Marden Fitch

Planning—before planting—a terrarium that will include a number of gesneriads. Included, top left to right: *Hypoestes sanguinolenta;* coffee tree seedlings; *Sinningia* 'Doll Baby'; *Gesneria cuneifolia; Pteris ensiformis* 'Victoriae'. Front: dwarf African-violet; *Peperomia* 'Astrid'; *Begonia boweri; Episcia.*

al deciduous periods of dormancy, but it will leaf out again. There are curious swellings like tubers on the stems. These are normal, not a sign of disease.

Aeschynanthus. *A. nummularius* is the only species in this genus small enough for most terrariums. This is a miniature creeper with distinctive heart-shaped leaves less than ½ inch long, spaced closely together in an overlapping fern-like pattern. The red flowers do not appear frequently, but it is worth growing for foliage alone.

Bellonia. This is a genus from the West Indies, consisting of two species, both of shrubby habit, and both with unusual small flat white flowers. *B. aspera* has 1-inch oval, rough-haired dark green stiff leaves. *B. spinosa,* with 1½-inch oval, thin light green leaves, has the distincton of being the only gesneriad with thorns. In a terrarium it will grow quite vigorously.

Chirita. Very few species of this large genus from Asia are in cultivation. Two, *C. elphinstonia* and *C. micromusa,* may be used in terrariums. They are very similar, the main distinction being brown throat markings in the former, while the latter has an unmarked clear yellow flower. Their rather curious growth habit makes them an interesting addition to a terrarium. The flowers form along the midrib of the primary oval leaf. Additional leaves and flower clusters may form, but some plants produce only a single flowering leaf. These plants are best raised from seed and the plants do not persist after flowering, but set seed pods readily.

Codonanthe. *C. carnosa* is a trailing plant with ½-inch oval, thick succulent leaves, sometimes with a colorful maroon reverse. The small white flowers are followed by bright orange berries. This plant blooms almost continually. It can be kept pruned to the size desired for the requirements of a terrarium.

Columnea. This is a large genus from Central and South America with many species and hybrids in cultivation. Most are too large or too fast growing to be

Dwarf cherry-red hybrid *Columnea* 'Mary Ann' does well under fluorescent lights.

Episcia 'Cygnet', a hybrid, has white fringed flowers. Needs warmth, moist air.

suitable for terrariums. Any of the small-leaved types such as *C. microphylla*, *C. arguta*, or *C. allenii* can be used in terrariums as foliage plants, but probably will not bloom in such a situation. *C.* 'Tricolor' is an unusually attractive cultivar grown for foliage with ½-inch leaves marked with pink and white mottling. It has flexible branching stems, well suited for terrarium growing. *C.* 'Pixie' is a miniature hybrid with dark green 1-inch lance-shaped leaves and orange flowers, which will flower in the low light and warm temperatures of a terrarium.

Episcia. This genus is characterized by having many cultivars with beautifully colored or metallic foliage, but growth is usually too rapid for the plants to be of more than temporary use for terrarium planting. The very beautiful pink and white leaved *E.* 'Cleopatra' or *E.* 'Pink Brocade' does become quite large, requiring sole occupancy of a container, but the effect is sufficiently outstanding to justify this monopoly. It usually requires a protective container to be grown successfully and cannot stand a temperature much below 70°F. A species with small, velvety dark green leaves is *E. dianthiflora*, which has beautiful fringed white flowers to compensate for the lack of glitter in the foliage. This is a good terrarium plant and can be kept pruned to fit the required space. Its stoloniferous habit can be used very effectively in plantings with a variety of levels. It can also withstand cool temperatures.

Gesneria. This is the genus from the West Indies for which the family was named. There are a number of attractive species small enough for terrariums. In fact, most species need this protection to grow well. *G. cuneifolia*, with red, orange or yellow narrow tubular flowers, has 2-inch shiny strap-like leaves radiating in a neat rosette. This species grows easily and flowers steadily. It is best raised from seed. *G. christii* has larger, more crinkled leaves which arch upward, but has a similar red flower. *G. citrina* has a more shrubby growth habit, 1-inch oval shiny leaves and clear yellow flowers. The red-flowered *G. saxatilis*, with holly-shaped

Gesneria christii has large, crinkled leaves which arch upwards. Plant has red tubular flowers and grows well in a terrarium.

Photographs by Charles Marden Fitch

leaves, is also shrubby but more erect, like a small tree. It can be shaped very effectively for decorative planting. *G. pumila* has narrow leaves covered with short hairs and white flowers. There is one hybrid now available, *G.* 'Lemon Drop' which grows easily and flowers readily, but becomes large for most terrariums, as the leaves are 4-5 inches long.

Koellikeria. *K. erinoides* is the only species in this South American rhizomatous genus. This plant forms a neat flat rosette of dark green leaves ornamented with silver spots. The inflorescence is an erect raceme of tiny pink and white flowers.

Kohleria. There are many large handsome species in this scaly-rhizomed genus which are not suitable for confined growing. However, two species can be grown in terrariums. *K. amabilis* has showy bright pink spotted flowers and mottled leaves, up to 2½ inches long. The newly introduced *K. platylomata* has bright red flowers and is somewhat smaller in size. Both these species have low growth habit and attractive foliage.

Nautilocalyx. This is a genus with a number of tall growing species, frequently grown as greenhouse foliage plants. There is one species, *N. picturatus*, which is low growing and could be used in a terrarium. It has handsome foliage of a dark color with a light green stripe down the midrib. The white flowers are large in size but last only one day. This plant forms a tuber.

Nematanthus. Most of the species in this genus are large shrubby plants. However, *N. wettsteinii* (*Hypocyrta*) has ¾-inch oval shiny leaves with maroon back and long-lasting red-orange pouched flowers of waxy texture. The trailing stems can be kept pruned back to the desired size. The hybrid, *N.* 'Cheerio', has similar growth characteristics with somewhat larger leaves and flowers.

Neomortonia. *N. rosea* is a newly introduced gesneriad with trailing stems of branching habit. The white and pink flowers are fringed like *Episcia dianthiflora*. The ½-inch oval leaves are closely set on very slender stems.

Pearcea. *P. hypocyrtiflora* is a rhizomatous plant with handsome 2-inch leaves, very dark green patterned with bright green and accented with pencil-line white veins. The red-orange ball-shaped flowers are unique among gesneriads.

Petrocosmea. This genus from Asia is closely allied to *Saintpaulia*. *P. nervosa* has 2-inch white-haired leaves and purple flowers. It forms such an extremely flat rosette that it provides welcome shape and texture in a terrarium.

Phinaea. An unusual characteristic of

Tiny *Gesneria cuneifolia* var. *quebradillis* is about 3 inches tall when its orange and yellow flowers open.

this rhizomatous plant is that the white flowers are cup-shaped, in contrast to the usual tubular or funnel-shaped flower of most gerneriads. *P. multiflora* is a small plant, quickly grown from seed. There are two forms, one with light green leaves, and the cultivar, *P.* 'Tracery' with dark green leaves about 2 inches long, marked with sharpy contrasting white veins.

Saintpaulia. The African-violet is the best known gesneriad, the ideal house plant for many. The usual types are rather large for a terrarium, but there are several miniature species and many cultivars. *S. shumensis* has a pale lavender flower with a deeper center spot. It has the typical rosette growth pattern. *S. magungensis minima* has a trailing habit and dark purple flowers. There are small rosette cultivars available in all the usual African-violet colors, with plain or variegated leaves. There are also miniature trailing types in several colors.

Sinningia. Of all the miniature flowering plants, the tiny sinningias are some of the most fascinating. *S. concinna*, *S. pusilla* and its mutants, *S.* 'White Sprite' and *S.* 'Snowflake', are all small enough to grow in a thimble. Despite their small size, they put forth an almost continuous supply of flowers. They grow from small tubers and will soon fill a terrarium with seedlings unless the pods are kept clipped off. *S.* 'Wood Nymph' and *S.* 'Bright Eyes' are small hybrids with purple and white flowers. *S.* 'Freckles' is similar but has a more erect growth habit. *S.* 'Krishna' has narrow tubular pink flowers. *S.* 'Tinkerbells' has an upright stem of 8 to 10 inches with tubular pink-lavender flowers and small dark oval leaves about 1½ inches long. This makes a good contrast to the low rosette plants. Another group of rosette-form sinningias are larger, both in leaf spread and in flower size. Of these, the lavender *S.* 'Doll Baby' is the most popular. Another excellent hybrid is *S.* 'Cindy', with white and purple flowers ornamented with dark stripes in the throat.

Streptocarpus. This genus from Africa has provided some interesting plants for terrarium use. Of two small species presently in cultivation, *S. rimicola*, with white flowers, is the easiest to grow; *S. cyanandrus*, having pink-lavender flowers with a darker stripe, is rather difficult. Hybrids of these species have recently been introduced and will probably be more satisfactory than the original species. These plants have one or two narrow leaves, and the flower stems are borne along the midrib of the leaf. Other larger species, such as *S. silvaticus* and *S. polyanthus* with one or more narrow strap-like leaves, or *S. variabilis* with a rosette of more rounded leaves, are possible choices for a terrarium.

A quite different type of *Streptocarpus* has erect or trailing stems and small leaves. *S. saxorum* looks much like a *Sedum*, having thick succulent leaves. It has handsome blue-lavender flowers, but is not apt to bloom in the reduced light of a terrarium. *S. caulescens* and *S. holstii*, two very similar spreading species with heart-shaped leaves, have much smaller purple flowers, but bloom more freely. They will grow rampantly, but can be cut back as necessary. The curious shiny swollen stems of *S. holstii* add variety to a planting.

Photographs by Charles Marden Fitch

Above: Miniature *Sinningia* hybrids, some still dormant, share this newly planted terrarium with *Helxine soleirolii aurea,* a golden form of baby's-tears. The generous spacing between plants allows for future growth. **Right:** The miniature *Sinningia* 'Pink Imp' has coral-pink flowers and grows from a small underground tuber. Sinningias do well under fluorescent lights in warmth and humidity.

A journey into a special world . . .

TERRARIUM MAKING FOR A YOUNG PERSON

Mary Ann Castellana

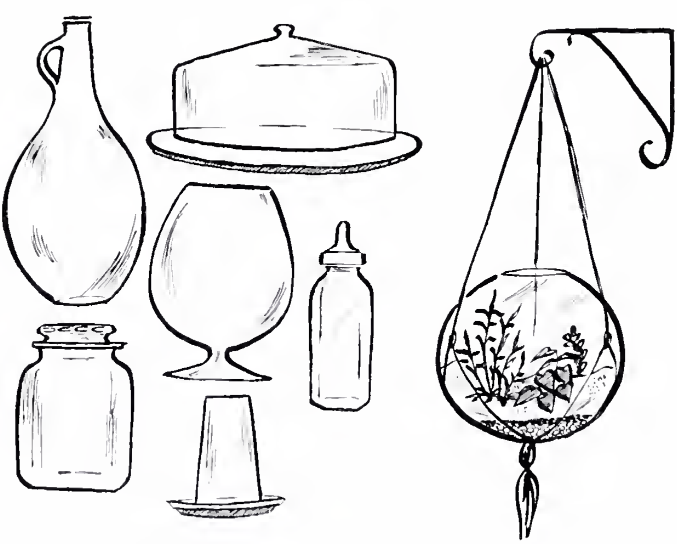
WHERE did you spend your vacation this year? Were you introduced to a world that was different from your own? Cindy and John, who spent two weeks with their family at a cabin in the mountains far from home, decided to make their holiday last by bringing back some of their discoveries.

Cindy, who is in the ninth grade, knew a little about mosses and lichens from her science class. Both children recognized the seedlings of the pine, hemlock and maple growing from the woodland floor. The most exciting discovery was the oak seedling with its acorn still attached. There were four other plants with interesting foliage, but it was not until they had taken home some books on woodland plants from their local library that they recognized them as partridgeberry, pipsissewa, rattlesnake-plantain and maiden-hair fern.

The children knew that they shouldn't dig the plants without the permission of the owner; but how were they to know who owned this particular spot of deep woodland? Then they remembered that man and nature rarely objected to a little digging of its plant life as long as it was done very carefully from an area where there are many more of the same kind of plants.

With a large spoon from the kitchen, John carefully dug the plants while Cindy put them in plastic bags. They then packed them, along with a bag of forest soil, into a shoe box. Like most young people who spend a vacation roaming the woods, John and Cindy brought home their share of oddly shaped or colored pebbles, small rocks, crooked branches and pieces of bark—some of which were covered with moss or the beautiful lichen known as the British soldier.

Back home, they wondered, as we all do, how to keep their plants alive indoors



Fancy glass containers are not necessary for terrariums—especially for beginners. Wine bottles, jars, brandy snifters, inverted drinking glasses, an old-fashioned baby bottle, or a hanging fish bowl are some of the possibilities offered by most households.

Children in terrarium-making projects learn how to carefully lift plants and how to observe common-sense conservation rules.

Mary Ann Castellana

to enjoy all winter!

Cindy's science room has a glass case called a terrarium. In it the teacher had planted insectivorous plants, which grow in nature where moisture and humidity are plentiful; and since woods are shady and damp, Cindy and John took an additional book on terrariums from the library.

A terrarium was described as "a bottle, bowl or other container enclosing a garden of small plants." A search in the basement uncovered an old fish tank, which Cindy and John thoroughly washed. Now all their woodland treasures, plus bags of perlite and charcoal from a garden center, were assembled on the kitchen table. An inch of perlite, lighter in weight than pebbles and sand, was spread evenly over the bottom and covered with half an inch of charcoal, which absorbs soil impurities and keeps a terrarium sweet-smelling. Then Cindy poured in the moistened woodland soil and formed a miniature valley and hills.

It was now John's turn to place the rocks they brought back and the piece of lichen-covered bark. At the lowest point an old mirror was positioned to represent a pond. They thought very carefully about where they would site their plants before actually digging the holes. Cindy washed each plant and inspected it for insects, then carefully removed most of the soil from the roots. A pine seedling topped the hill and an oak seedling nestled in a lower corner. The rattlesnake-plantain was placed beside the lake, pipsissewa peaked out from behind one of the rocks, partridge-berry crawled over the other, and maiden-hair fern grew gracefully by the piece of bark. Patches of different kinds of moss were laid here and there over the imitated forest floor. It was John's idea to allow a little ceramic duck to swim across the mirror-pond.

Using a mister of the kind used in washing windows, Cindy cleaned the sides of the terrarium and sprayed the leaves. She was careful not to over-wet the soil because the excess water has no place to go. A piece of glass, cut just a little larger than the terrarium top and whose edges had been covered with strips of masking tape, became the roof and completed the new little world with its own climate and atmosphere.

Cindy *may* have applied the correct amount of water, but a few days must go by while they observe the glass case. Tomorrow, if the soil is still dry, she'll add a little more but not allow the water level to reach the top of the drainage material. If a lot of droplets appear on the roof, it means the inside is too wet, and she'll then pull the roof back part way

Diversity—in container shape, technique and style—can be expected from children's terrarium classes.

or use a flat eraser to lift one end of the lid. Cindy will repeat this until there is only a slight mist on the glass at night. After that she can close the lid with no additional watering needed probably for several months.

Cindy and John are delighted with their little glassed-in woodland, but now they must decide in whose bedroom it will live. Their terrarium book said cool temperatures and light are necessary, but never direct sunlight. So, the terrarium was placed in John's room, which faces north, not in Cindy's room, which looks west and receives a lot of sun.

Not every plant will live in John and Cindy's first experiment with a terrarium. If a plant dies, it should be carefully removed and replaced with another. This may require another trip to the woods. Or, a search of one's own backyard can often turn up tiny trees and shrubs, sprouting from seeds that drop to the ground or are spread by the birds. However, sometimes nearly everything thrives and all that may be required in terrarium housekeeping is the removal of a dead leaf or some mold, growing because the case is too wet.

Terrariums may be any shape or size—from an old-fashioned glass baby bottle or a drinking glass inverted over a flat dish, to a narrow-necked bottle or hanging fish bowl. As long as it is clear glass or plastic and can be covered with a glass lid or plastic wrap, let your imagination take wings. The construction will basically remain the same, but it's a good idea to place sheet moss along the sides of the terrarium to hide the edges of the exposed soil and drainage; or a bed of smooth pebbles imitating a dry river bed could be used instead of a mirror-pond. Several books will illustrate the tools needed to plant a narrow neck bottle—tools which you can easily make yourself. See the ones by Barbara Grubman and John Hoke on page 11.

If you don't live near the woods, then plant your terrarium with tropical kinds that also grow well in a humid atmosphere. Visit a garden center and ask for miniature or very slow-growing plants. Two good, easy-to-grow carpeting plants are selaginella and baby's tears. Even an African-violet all by itself in a small fish bowl or small brandy snifter is exciting. And the science students might prefer growing some of the insectivorous sorts—pitcher plant, Venus fly-trap and the sundew.

Why don't you create a terrarium like Cindy and John did? In caring for your miniature plant world you may learn that there is only a fine survival balance between the plants themselves, but a unique one between plants and man that must not be destroyed.

A small woodland terrarium featuring ebony spleenwort, spotted wintergreen or pipsissewa (*Chimaphila maculata*) and various mosses.

Charles Marden Fitch

A traditional kind of terrarium . . .

NORTHERN WILDLINGS FOR THE TERRARIUM

Viki Ferreniea

GROWING native plants in terrariums in the home can be a very satisfying and pleasurable extension of outdoor gardening. In acquiring plant material there are several points to be considered. Much can be collected from the wild, but it is important not to destroy our native flora in this endeavor. Plants on protected lists should not be collected, nor should rare and difficult-to-grow material be removed from native haunts without a measure of assurance that they will succeed in cultivation.

Frequently, one has more reasonable expectations of success with smaller, often immature plants or cuttings than with transplants of mature specimens. This is particularly true of trailing material. Use discretion and take sparingly from the wild unless the area is scheduled for immediate destruction due to construction activity. Remove only a few plants or pieces of material from the original colony. It is important always to have permission from the landowner before collecting any material.

Dormancy

Plants from the northern United States, as from all of the temperate zones, naturally undergo a dormant period in winter. This factor can for a while be overlooked when material is grown in terrariums. No specific rules can be laid down for such a wide range of plants, and in many cases little information is available on the dormancy requirements of the majority of our natives. Generally, if temperate zone plants are kept growing and flowering continually with no rest period, they will in time start to decline and eventually may be lost.

In any event, terrarium material will sooner or later become overcrowded and be in need of reorganizing, replacing or replanting. This provides an opportunity for excess plants to be potted up or planted outside for the winter months to undergo a natural dormancy, with the thought of using this vigorous material for replacement. Or, the whole terrarium can be put somewhere cool and dark, as in a basement, garage or under a bench in a cool greenhouse where the temperature is kept well below that in the average home. And in so doing, the plant is given the rest period it needs to remain healthy and vigorous.

Suitable Plants

(Plants listed with an asterisk are only suitable for large terrariums.)

Twinflower (Linnaea borealis)—In the wild twinflower is found in cooler parts of the northern states or at high elevations in the South. The typical habitat is in cold acid sphagnum bogs, where the plant trails over rotting logs, rocks and tree stumps, intermingling with bunchberry (*Cornus canadensis*). It often is seen in full sun. In June short stems bearing pairs of delicate pink blossoms cover the plant. Twinflower does well in a terrarium if the soil is kept cool and moist.

Goldthread (Coptis groenlandica)—Acid moist woods and bogs are the haunts of goldthread. Its trailing stems carpet the ground with bright shiny leaves, and in May masses of small white star-like flowers appear. Providing there is ample moisture, it is quite satisfactory in full sun. A similar species, *C. trifolia*, is found in the Northwest and might be tried by terrarium growers there.

Sundew (Drosera rotundifolia)—In a terrarium where sphagnum moss has been established, sundew will grow happily tucked into the moist moss. The sticky leaves of this insectivorous plant form basal rosettes. In June white flowers are borne on spikes 2 to 4 inches high, clearly distinguishing the tiny sundew from its surroundings.

Small Cranberry (Vaccinium oxycoccus)—A number of vacciniums are suitable for use in terrariums because of their prostrate trailing stems and small size. The small cranberry comes from acid bogs and needs to be grown in a situation that is constantly moist. In June tiny

Twinflower

Photographs by John A. Lynch

Goldthread

Sundew

Downy Rattlesnake-plantain

Small Cranberry

Shinleaf


Partridge-berry


Dewdrop


Creeping-snowberry


Trailing-arbutus

Three-toothed Cinquefoil

Rattlesnake Fern

pink flowers, resembling those of shooting star (*Dodecatheon*), begin to open. They are followed in autumn by pink berries.

Downy Rattlesnake-plantain (Goodyera pubescens)—The handsome evergreen basal rosette of leaves with prominent creamy-white veining makes this orchid well worth growing even if it did not flower. But in August spikes 4-6 inches high are produced, carrying many small white blossoms. The plant requires an open acid soil and shady situation. In time it will form a sizable colony.

***Shinleaf (Pyrola rotundifolia)**—The shinleafs are stoloniferous plants of very acid woodlands, where they form large colonies early in the summer. Nodding white flowers brighten the woods, blooming along 4- to 6-inch tall stems.

Partridge-berry (Mitchella repens)—This charming plant is found trailing over woodland floors in a wide variety of situations. The small, dark evergreen leaves make a perfect backdrop for the pure white flowers that are produced in June and are later replaced by bright red berries. Easily raised from cuttings.

Dewdrop (Dalibarda repens)—A rare and delightful little ground cover from swamps and moist woods. The trailing stems root easily from cuttings and in time form nice colonies. Typical white rose-like flowers appear in June and continue into the early fall.

Fringed Polygala (Polygala paucifolia)—A rather difficult plant to establish in the garden but it lends itself to terrarium culture. The orchid-like purple flowers, which have an almost exotic appearance, cover the plant in May. It is found in a wide range of woodland habitats, usually those having sandy soils. The very rare white-flowered form is well worth looking for.

Creeping-snowberry (Gaultheria hispidula)—Away from its native haunts, the sphagnum bogs and wet woods of the northern states and mountains of North Carolina, this is a difficult plant to bring through the winter without a deep snow cover. However, grown in a terrarium, it thrives among rotting wood. The flowers are inconspicuous but are followed by

Ebony Spleenwort, left, and above, downy rattlesnake-plantain as it looks in full bloom in midsummer.

handsome white berries which make a striking display. Like the following two species, creeping-snowberry is ericaceous and requires acid soil. Creeping-snowberry is sometimes listed under *Chiogenes.*

*__Wintergreen (Gaultheria procumbens)__—Handsome, glossy evergreen leaves make this an attractive ground cover. Pendulous white bell-shaped flowers can be seen in July and bright scarlet berries in the fall. It is found in a wide variety of habitats but needs humusy soil. When grown in full sun the foliage will turn a dark bronze color in autumn.

*__Trailing-arbutus (Epigaea repens)__—One of our loveliest early spring wildflowers, this plant bears fragrant white or pink blossoms, usually in great abundance in early April. It is difficult to transplant in the garden, but this can be done with greater success if plants or cuttings are established in a terrarium first.

Three-toothed Cinquefoil (Potentilla tridentata)—A little known plant of the rose family but one worthy of cultivation. In June and July numerous white blossoms are carried above the foliage on stems 3 to 4 inches high. Poor gravelly soils and rock crevices are its most favored habitat.

Ebony Spleenwort (Asplenium platyneuron)—Many of the spleenworts are well suited for growing in terrariums which contain small fragments of rock. Most require a calcareous soil but the ebony is quite content in an open woodsy soil. By the end of May the delicate fronds of this fern are fully expanded, usually reaching 6 or 8 inches in height but they can get as tall as 12 inches or more under optimum conditions. They make a very nice contrast for lower-growing material.

*__Rattlesnake Fern (Botrychium virginianum)__—This diminutive fern does not appear much before early summer and seems equally at home in short grassy meadows as in woodlands. The fertile fronds are carried above the sterile ones and form attractive cinnamon plumes.

Out of the tropics and into our homes . . .

TROPICAL MINIATURES FOR TERRARIUMS

Charles Marden Fitch

DIMINUTIVE TROPICALS are the stars of my terrariums for they provide an infinite variety of color and form in limited space.

Along with miniature gesneriads and orchids, I enjoy growing restrained creepers, seedlings of tropical shrubs which remain small for a year or more, and a wide assortment of other warmth-requiring plants from around the world.

What is a Miniature?

An all-inclusive definition isn't practical because what may be small for a palm is huge compared to the smallest begonia. The size of the container also influences scale. In a spacious modern plant case with a few square feet of space, or a big table terrarium, we can easily grow the dwarf rex begonias and a few small palm seedlings.

However, if the terrarium is a brandy snifter or modest plastic container, we should landscape with 2- to 3-inch tall *Begonia boweri* and its hybrids, tiny creeping *Ficus pumila minima*, or perhaps create a desert landscape of slow-growing miniature succulents in an uncovered container.

Age and Maturity

Fern sporelings and young plants of many tropicals have a different leaf form than when these same species are mature. Tip cuttings or divisions from mature specimens in most genera become established and bloom more quickly than seed-grown plantlets. These are factors to consider when planning a terrarium garden.

If you want an immediate finished effect, plant with groomed mature specimens. To create a tailored landscape over a period of months, with occasional replanting and pruning, start with seedlings or cuttings from young plants. (A fully illustrated demonstration of these techniques is presented in my book *The Complete Book of Terrariums*, Hawthorn Books, New York.)

For all but the succulents (which are to be in uncovered containers) you will notice that even miniature plants grow slightly larger and somewhat faster in the protected humid atmosphere of a terrarium. My plants of *Begonia* 'China Doll' have 1- to 1½-inch long leaves when grown out of a terrarium and they remain at home in a 2½-inch pot for many months. This same cultivar produces 2-inch leaves and quicker growing stems in a terrarium.

Favorite Miniatures for Foliage

Among the most attractive and adaptable miniatures in my collection are these treasures:

Adiantum hispidulum is a delicate-looking maiden-hair fern which has done well in a planting with *Anoectochilus*, a terrestrial jewel orchid. The fern has thin 2- to 4-inch stems topped with closely spaced leaflets, creating a canopy of green over the red and olive orchid.

Anthurium clarinervium and *A. crystallinum* are both thick-leaved species with heart-shaped leaves veined in silver, practical in the seedling stage but eventually reaching 12-15 inches. *A. polyschistum*, a slow-growing trailer, will often remain upright for months if started as a tip cutting. The dark green glossy leaf, 4 inches across, resembles marijuana with its many lobes. It is a palmately compound leaf unlike that of any other terrarium subject.

Begonias. The ones most suitable for

A traditional berry bowl (center) contains woodland plants from the temperate zone. The modern terrarium (left) is a rain forest of ferns and other tropical plants. The 12-inch Terra-Cube (right) holds *Dracaena sanderiana, Anthurium polyschistum* and *Sinningia* 'Doll Baby'.

foliage also produce spires of small white or pink flowers but those listed here are attractive even without flowers.

Begonia boweri nigramarga, a 2- to 3-inch tall creeping species from Mexico, has dark bronze-green leaves edged all around with thin silver hairs, thus the popular name of eyelash begonia. *B.* 'Smidgens' is the smallest cultivar of variety *nigramarga.* Fortunately, *B. boweri* usually contributes dwarf growth and leaf hairs to its numerous hybrids, such as the delightful 'China Doll' (black with green center) and 'Midget' (bronze, copper and green). *B.* 'Dresden Gold' is a hybrid with maple-shaped, copper-toned leaves.

Begonia rex cultivars are the first choice for brilliant foliage color but not many are compact enough for terrariums, once they mature. One of the smallest available, excellent in medium to large terrariums, is 'Dew Drop', which has an oval silver leaf with pink blush. 'Peridot', smallest of the lot at 2-3 inches tall, is a dark bronze mound of closely spaced 1-inch foliage, attractive with the golden *Selaginella kraussiana aurea.* 'Robin' is an upright 4- to 6-inch tall olive-green rex with leaves that are heavily blushed red and splashed with silver.

B. pustulata is a trailer with dark brown plush leaves having silver marks, and *B. versicolor* forms a mound of velvety green marked with silver and bronze. Equally striking is *B. masoniana* with puckered rough-surfaced foliage in medium green decorated with a dark brown Maltese cross. This species soon reaches 10 inches across, so use it in larger containers.

Caladium humboltii is a 6-inch tall species I first saw in the Amazon jungles of Brazil and Colombia. It is a rare slow-

Photographs by Charles Marden Fitch

The best light for adequate growth in terrariums is from fluorescent lamps, here helping a newly planted terrarium to become established without danger of burning the plants.

growing gem, very hard to find in catalogs, but worth searching for. While you are waiting to find *C. humboltii*, grow 8- to 10-inch tall *C.* 'Candidum Jr.', which has a cool white and green leaf and is suitable for larger containers. Place this plant toward the back of landscapes in big glass tanks or Wardian case terrariums. (It is available from the Geo. W. Park Seed Co., Greenwood, South Carolina 29646.)

Cryptanthus are terrestrial bromeliads delightful for a dash of color in otherwise all-green landscapes. One of my favorites is *C. bivittatus minor*, a 1- to 2-inch tall rosette of thick foliage striped cream, pink and green. It is most colorful in bright locations. Small plants of *C. fosterianus* and *C. zonatus* are appealing for their alternating lines of bronze and silver. The leaves resemble a snake skin. Various new hybrids are blushed red, pink, or cream.

Davallia fejeensis and *D. griffithiana* are feathery ferns with rhizomes that creep above the ground. They are suitable as sporelings or small divisions. Some I collected in Tahiti survived a long trip packed in moist tissue, then established themselves in a lucite terrarium where they have been at home for two years now.

Fittonia verschaffeltii, a creeper from the jungle floor of Peru, grows 1 to 3 inches tall, eventually carpeting considerable ground but most satisfactory for many months if planted as small divisions. The veins in variety *argyroneura* are white, while variety *pearcei*, a slightly more robust type, has deep pink veins.

Peperomia species are rewarding in terrariums if not kept too wet. In the tropics many species grow as epiphytes around the roots of bromeliads or orchids. Others

Photographs by Charles Marden Fitch

Bird's-eye view of an established terrarium. The plants have grown to perfection under wide-spectrum Gro-Lux tubes, and show varied textures, colors and forms. Plants include *Selaginella* species, small begonias and the dwarf fern, *Polystichum tsus-simense.*

are found in well-drained soil or on mossy rocks. Try *P.* 'Emerald Ripple' (deep green, pebbly round leaf), *P. griseo-argentea* (many metallic foliage), and *P. rubella* (small pink and green leaves marked silver, borne on rambling stems).

Pilea species are usually small but must be pinched and thinned, for they grow fast once established. *P. cadierei,* known as the aluminum plant, has shiny white-splashed foliage. *P. involucrata* and *P. repens* have crinkly dark bronze leaves and tight flowers resembling tiny cauliflowers. *Polystichum tsus-simense,* a 4- to 8-inch tall, slow-growing fern, is a perfect terrarium choice.

Sonerila margaritacea is a rare find, quite striking in a terrarium. Stems and leaf veins are pink, much of the foliage is matte white. My plant remained small for several months but then grew to 5 inches, an appropriate height for a tip pinch to keep the clump compact and provide propagation material for more of this unusual jewel.

Ground Covers

Ficus pumila minima, a tiny ornamental fig, is a thin-stemmed creeper with closely spaced, rough-surfaced oval leaves. It is most interesting in the oakleaf form (*quercifolia*). Plants will climb and cling to driftwood or rocks or carpet the ground.

Gibasis geniculata is a relative of *Tradescantia* and *Zebrina* but more restrained in habit. Thin stems carry 1-inch maroon blushed olive-green pointed leaves. In adequate light the plant bears multitudes of tiny white flowers.

Helxine soleirolii, baby's tears, and nearly identical-looking *Nertera granadensis* form 1-inch creeping mats but will have to be trimmed often to keep them from covering small companions such as the mini sinningias.

Pellionia daveauana grows rapidly but is easy to control by pinching stem tips. The lance-shaped shiny foliage is brown along the edges, gray-green in the center. *P. pulchra* is slower growing and has silver-green leaves veined dark green, Begonia 'China Doll' in a 1½-inch tall mustard cup salvaged from a Chinese dinner—the perfect pot for this miniature begonia.

borne in pink-toned stems. Both species are from warm Southeast Asia.

Plectranthus oertendahlii has dark green velvety foliage with silver veins, and spires of white flowers. It is more restrained than the robust, glossy-leaved *P. australis*.

Saxifraga stolonifera (sarmentosa) 'Tricolor' is a pink and cream cultivar of the popular strawberry-begonia. When first planted, the typical species, which grows 1-2 inches tall, forms a rosette but in a few months runners appear on which grow a multitude of plantlets, soon forming a ground cover. Since 'Tricolor' grows more slowly and is brighter than the type I prefer it in terrariums.

Vines

Cissus striata, the smallest grape-ivy, is fine to train over a log or on a tiny trellis. The stems and bottom of the foliage are pink, growth is twining and appears delicate, but in a terrarium the vine needs constant pruning. In fact, it will even form a mound of airy stems if constantly kept from trailing.

Hedera helix (English-ivy) cultivars are often too big for terrariums but 'Itsy Bitsy' is a restrained, tightly leafed form, similar to better known 'Needlepoint'. For upright growth select 'Erecta', a slow-growing plant with typical ivy leaf shape.

Tree Effects

Biophytum sensitivum, sometimes known as "the life plant," looks like a tiny palm tree. The ferny leaves fold at night, and the plant grows slowly to 3-6 inches tall. It is a delight.

Oxalis hedysaroides rubra, called fire-fern, has dark red leaves and yellow flowers. Tip cuttings look like tiny trees for months. With pinching it develops into a small bush.

Punica granatum nana, the dwarf pomegranate, is actually a small tree that, with pruning, can be kept under 8 inches tall. The pink or orange flowers form small fruits if you pollinate them.

For Flowers

Allophyton mexicanum is a Mexican perennial which forms a low rosette of leathery, dark green foliage, then produces a succession of lavender flowers resembling tiny foxgloves (*Digitalis*). The thin flower spike has many flowers over a period of weeks, then usually sets seed. For maximum flower production cut off old spikes as they finish blooming.

Anthurium scherzerianum grows to 12 inches tall in a year or so, but as a young plant or small division it is suitable for medium to large containers. The waxy pink-to-red spathe lasts 30-40 days in perfection.

Begonia prismatocarpa forms a 1- to 3-inch mound of medium green leaves and is soon spotted with yellow flowers. A slightly larger selection with 1-inch yellow flowers marked red is 'Buttercup', a hybrid of *B. prismatocarpa* and *B. ficicola*.

Photographs by Charles Marden Fitch

Dwarf rex begonia 'Robin' has red, green and silver leaves. For larger terrariums.

Peperomia japonica on coral rocks in Tahiti. Take this tip from nature and grow peperomias on small chunks of lava rock.

Exacum affine 'Midget', a dwarf 4- to 8-inch tall cultivar of the popular Persian-violet, has a constant display of light blue flowers with yellow stamens. They have a delicate fragrance.

Oxalis regnellii makes a 2- to 3-inch clump of clover-like leaves, olive above, purple below, then has a never-ending display of white flowers. For neatness old stalks must be cut off as they die. Propagate from stem scales or sections of the underground rhizome.

Succulents

These plants, especially the desert cacti, are well adapted for life with low humidity, infrequent water and bright light. It's not necessary to give succulents terrarium protection but in uncovered containers they will survive. I like to see miniature succulents in mixed landscape plantings with cholla wood, rocks, and in contrasting shapes with various compatible species.

It's easier to appreciate the intricate beauty of small succulents when they are planted together in a crystal bowl or similar container with good air circulation. The miniature succulents, especially, have much more appeal planted in a landscape than set in a mass of individual pots.

Planting: Select species that are compatible according to light requirements and moisture needs. The desert cacti require the strongest light, least water. Many other succulents come from regions where they are protected from midday sun by low bushes, tall trees, or grass. These types include some among *Aloe, Crassula, Haworthia, Stapelia* and similar genera.

Put sandy soil over an inch or two of gravel. Add granulated charcoal to the soil mix or put several chunks of hardwood charcoal in the drainage layer. Keep the planting in direct sun (except at mid-day) or close under broad spectrum fluorescent lamps. The broad spectrum brands include Wide-Spectrum Gro-Lux, Agro-Lite, Vita-Lite, and Verilux Tru-Bloom. There is little danger of burn with fluorescents, even when the lamps

The "Mexican-foxglove" (*Allophyton mexicanum*) has light lavender foxglove-like flowers that appear all year on established plants which thrive under fluorescent lights.

are just 1 to 2 inches above the foliage.

Selections: Genetically dwarf succulents are not sold by many nurseries but current offerings may be found in classified ads of the "Cactus and Succulent Society Journal." (The Abbey Garden [176 Toro Canyon Road, Carpinteria, California 93013] offers a miniature cactus collection and a large selection of dwarf succulents in its illustrated catalog.) Some local garden stores have small succulents at low prices but these are often unlabeled.

Agave striata nana, a dwarf form, has gray-green foliage. *A. stricta* is bushy and thin-leaved, and is fine as a seedling. Young plants of *Agave victoriae-reginae* have symmetrical, thick dark green rosettes with white leaf edges and spine tips.

Aloe bellatula is a 3- to 5-inch fleshy clump of upright leaves, brown blush in the center and no stem shows. *A. haworthioides* forms a dense 2- to 6-inch tall deep green clump with silver hairs. It is a gem. *A. pratensis* is like a tiny agave, grows 1 to 3 inches, and hugs the ground with plump blue-green leaves. *A. rauhii* grows 1 to 2 inches tall, and the open growth is pink gray with light gray spots. *A. variegata* is a common dwarf species worth growing for its stiff upright leaves, which are marked white and have small teeth along the margins. An unusual plant form.

Crassula argentea, the jade plant, is suitable as a cutting but in a year or so will reach 8 to 10 inches. More restrained are *C. perforata*, with 2- to 6-inch upright or arching stems and gray-green leaves in pagoda style and *C. lycododioides* with thin 4- to 6-inch stems bearing dark green leaves that resemble braided leather. *Echeveria* species such as *E. derenbergii* (glaucous silver-white, tipped red) and *E. pulvinata* (plush gray-green leaves tipped pink, 3 to 5 inches tall) are delightful. They are not hard to locate in catalogs.

Gasteria batesiana and *G. liliputana* are 3 to 4 inches tall, symmetrical species with tongue-shaped leaves marked with white. *Haworthia* species combine

Right: Small succulents suitable for planting together in a desert-style landscape in an uncovered container. Back row, left to right: *Crassula lycopodioides, C. perforata, Haworthia papillosa.* Second row, left to right: *Echeveria* species, *Crassula ericoides, Kleinia repens.* Front row, left to right: *Portulacaria afra variegata* and a living-stone (*Pleiospilos* species). **Below:** This dwarf creeping tongue fern (*Pyrrosia lingua*) will be planted in a hollowed-out lava rock for terrarium decoration.

Photographs by Charles Marden Fitch

well with dwarf aloes. Look for *H. fasciata, H. subfasciata* and *H. papillosa,* which are all 1- to 3-inch dwarfs with pearly white markings on dark green, formal rosettes. You could plant an extensive miniature landscape with haworthias alone, for there are many available.

Portulacaria afra variegata is a tiny sub-shrub with pink, cream and green leaves. It looks rather like a small jade plant.

Sedum species suitable in bright terrariums include *S. morganianum,* a silvery trailer for growing over rocks, *S. multiceps,* which resembles a small desert tree and *S. pachyphyllum,* which has fat jellybean leaves that are gray with a red tip. *S. rubrotinctum* is similar but more compact.

Stapelia semota lutea (yellow flower) and *S. variegata* (yellow flower with purple markings) are attractive clumps of 3- to 4-inch upright green "fingers" even without flowers.

Cacti: Among the desert ones, small species of *Mammillaria* and *Rebutia* are suitable in bright airy plantings. The jungle cacti such as *Rhipsalis* are at home in hollow lava rocks or growing over ledges. They accept more humidity and need less intense light than desert species.

A selection for the open "terrarium" . . .

DESERT PLANTS

DESERT dwellers have become popular in terrariums in recent years. The miniature cacti and other succulents of our American deserts of course don't require, and in fact, suffer from the humidity of closed cases, but you can grow them in open-top terrariums for purely decorative purposes. A standard soil mix is half sand, half soil and a smidgen of finely ground peat moss. Give an initial watering as you would with any terrarium plant, but only sparse waterings later. The containers should have full sun.

W. Hubert Earle, Director of the Desert Botanical Garden in Phoenix, Arizona, has provided us with the accompanying photographs and information on some of the most appropriate terrarium plants from the southwestern United States. He stresses that they should not be collected, since current interest in cacti and other succulents may cause some to be endangered. Rather, obtain them from a nursery or grow from seed.

Photographs by W. Hubert Earle

A 12-inch cylindrical fish bowl becomes a desert garden with the aid of rocks, soil, and of course, plants—cacti and succulents. Combining both kinds makes a realistic desert landscape, the leaves of the succulents providing contrast to the globular forms of the cacti. If the bowl is left uncovered, watering should be weekly, with the moisture creeping to within about 2 inches of the bottom of the bowl. If a glass is placed over the opening, allow ¼ inch space for ventilation, and water once a month.

Agave parryi—Parry's Agave. This plant is 3 inches wide; stays attractive for 5 years, then gets too large. Plants flower once and die at about 19 years of age.

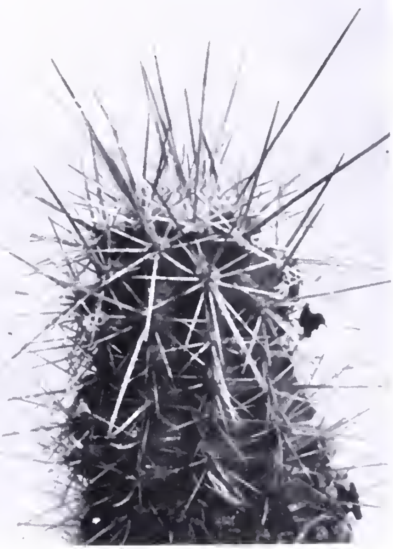
Carnegia gigantea—Saguaro. A 3-year-old, 2-inch high plant can grow in a planter for 10 years. The plants do not develop "arms" until 80 years of age.

Cercidium floridum—Palo Verde. This becomes a tree, but can be cut back continuously when young and while bark is green. Start from seed and transplant.

Cylindropuntia leptocaulis—Desert Christmas Cactus. A golden-spined cholla with red fruits at Christmas. Cut large plants in half and plant cut-off part.

Cylindropuntia ramosissima—Pencil Cholla. This well-branched cholla can be cut back when too large for planter. Beware of spines—handle with tongs.

Echeveria arizonica—Hen and Chickens. A small whitish gray plant that never gets over 2 inches. It lives on a very small amount of moisture.



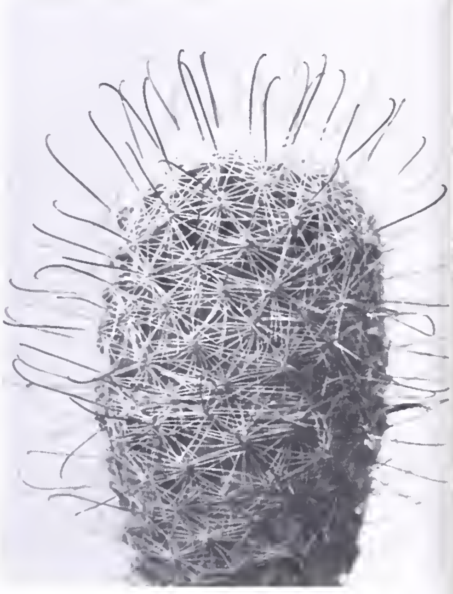
Echinocereus engelmannii—Hedgehog Cactus. A 5-year-old plant that is only 3 inches tall, including the spines. Slow growing—good for open terrariums.

Eriogonum fasciculatum—Bush Buckwheat. A lovely, small bushy plant that must be started from seed and transplanted. It has pretty, small pink flowers.

Fouquieria splendens—Ocotillo. This 3-year seedling will stay small for years. Leaves drop when soil dries, but new leaves form when soil becomes moist.

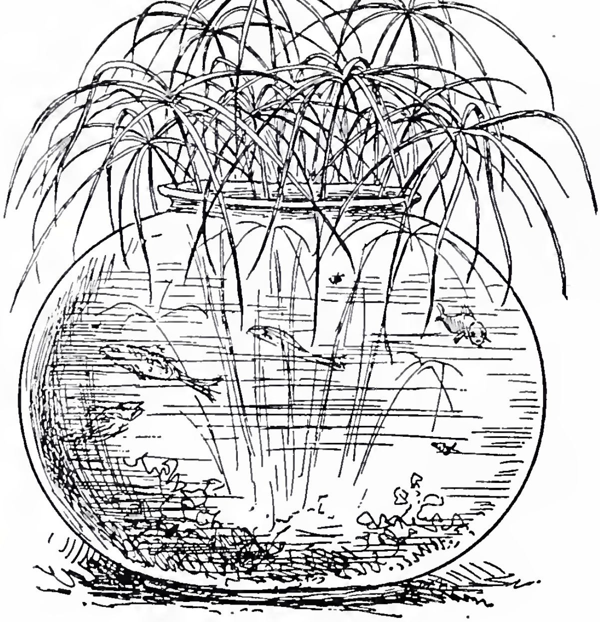
Franseria deltoidea—Burr-sage, Desert-sage. A composite with gray, sage-like leaves. Trim back when too large. Grow from burr-like seed pod.

Larrea tridentata—Creosote Bush. A plant of the Sonoran Desert. Start from seed, then squeeze off excess branches. Leaves have creosote odor when damp.



Mammillaria microcarpa — Fish-hook Pincushion. A lovely little plant—typical of the desert. The hooked spines can repel animals and man.

Above: An aquarium now used as a terrarium for cacti and succulents. Four water faucet washers have been glued to each corner to support a sheet of glass which will permit ventilation—necessary for a desert garden—yet retain some moisture. About a half cup of water monthly is sufficient watering. When plants get too large, remove and place in pots. Replace vacated plants with new small plants. **Right:** A 10-inch fish bowl filled with cacti.



A turn-of-the-century nursery catalog (James Vick's Sons, Rochester, N.Y.) featured this illustration of the umbrella plant (*Cyperus alternifolius*). It was described as an easy-growing plant, showy for pot culture, one of the best for ferneries, "while for the aquarium it is without an equal."
From Robert C. Baur Collection

With or without fish . . .

AQUATIC TERRARIUMS

Robert C. Baur

It is no wonder that aquatic gardening has become popular again. Graceful water plants and the attractive glass containers holding them are a refreshingly cool combination that provides year-round beauty in our modern dwellings. Aquatic gardens are very easy to plant and maintain, and they don't require much time to develop a pleasing display. A bonus, especially appreciated if we live in a hot, dry apartment, is their humidifying effect. This is beneficial not only to our health but to that of African-violets and other house plants growing in the same room.

Containers

The choice depends on personal preference as well as the space and decor of the display area. Beside the conventional multi-gallon tanks and fish bowls, there are brandy snifters, cookie and food-storage jars and contemporary glass containers of varied design. Also included are clear glass bottles or slightly tinted ones, each with openings large enough to admit plants and tools.

Of course, tank-type aquariums offer possibilities for extensive plantings. These containers are usually mounted in stainless steel or plastic frames. Smaller tanks of one or several gallons, molded from a single piece of plastic, are more durable and there are no rusted areas or leaking seams to repair.

Water

Any sizable aquatic garden requires sturdy support. A gallon of water weighs more than eight pounds, so estimate a five-gallon container to weigh at least forty pounds. Another consideration is the possibility of aquariums developing leaking frames. Place them where water won't damage household furnishings.

Most fresh water plants, whether from the temperate zones or tropics, are native to areas with varying degrees of hard (acid) or soft (alkaline) water, and the ones that find their way to our aquariums are tolerant of a fairly wide pH range. Generally, tap water is acceptable and, unless it is extremely alkaline, plants will adjust. However, it should be allowed to stand for at least 24 hours before plants are introduced. This aging process permits chlorine and other chemical additives to evaporate.

Hard water is measured by high calcium or magnesium content. These minerals do not evaporate with the water and will leave a light residue along the water line. In extreme hard-water areas where soap won't lather, use rain or distilled water.

Hard water can be softened by adding small amounts of aged water each month or by boiling shredded sphagnum moss in it. Fresh sphagnum will darken the water unless soaked in baking soda and washed repeatedly. Extremely soft water can be hardened with pieces of limestone.

Temperature and Light

Some aquatic plants grow best in cold water, others in warm, but most perform satisfactorily at average room temperature. The ideal for the majority is 65°. However, if tropical fish are to be included in the aquarium, bear in mind that they require a temperature of at least 75°.

Overly warm water reduces the oxygen content, a condition to be guarded against in larger aquariums which retain heat. When the aquarium is grown under artificial light, the surface water will be warmer than the water at the bottom of the tank, but this is a situation comparable to natural surroundings.

Light not only displays plants advantageously but is essential to their growth and production of oxygen to support fish. Energy absorbed by plants from sunlight is taken in as carbon dioxide and given off as oxygen. Several hours of filtered or morning sun, as given by an east window, are suggested. Stronger light overheats the water, reducing oxygen and promoting growth of algae.

If you decide to use artificial light, about twelve hours must be provided daily to be effective. Fluorescent tubes

Water garden in a bottle. The plant is *Dracaena sanderiana*, which is semi-aquatic.

of the Gro-Lux type used for house plants emit red and blue rays conducive to plant development. A 60-watt incandescent light bulb in a table lamp will supply enough light for small bottle plantings if burned long enough.

Because aquatics are grown primarily for display, place them where light complements the planting. Wherever possible, daylight should strike the front or viewing side of larger aquariums, since it eliminates the need for turning heavy tanks (to straighten up plants growing toward the light). This is no problem with smaller containers, which are easily rotated.

Gravel and Rocks

Gravel is as decorative as it is useful. It anchors "root-type" aquatics and gives the setting a realistic underwater look. Use only medium or finely gritted gravel; sand hardens, preventing water circulation and root penetration. Coarser pebbles will collect dead leaves and other objectionable matter.

Don't use beach gravel, which contains salt or calcium. Always wash aquarium gravel thoroughly. Rinse under the faucet and drain repeatedly until the water is clean, otherwise it will take several days for the container to clear. How much gravel to buy is determined by aquarium size (roughly two pounds for every gallon of tank capacity).

Rocks are not essential but impart a natural touch. Use whatever you like if the rock contains no harmful minerals and conforms to aquarium size.

Featherock, a lightweight porous volcanic stone, is easily shaped to aquatic garden plans. Soak before placing, or it may float. Crevices cut in this soft rock will retain bunch-type aquatic plants until they become established.

Tools and Cleaning

No special tools are required for tanks you can get your hand inside of. However, if the opening is too small, long-handled assembling aids are needed. The most useful is a wooden dowel, notched on one end to prevent injuring roots. Other equipment includes a hooked wire for pruning (also pliable enough for cleaning glass) or any terrarium gripping tool and a beverage funnel and plastic tubing for depositing gravel. Make these tools a hand grip longer than the depth of the container. You will find them useful for arranging foliage in tanks full of water, too.

Cleaning is accomplished with a dip tube for siphoning out debris, and an algae scraper (razor blade or plastic sponge). Bottles are cleaned with a percolator brush or cloth tied to the pruning wire.

Other accessories are primarily associated with fish. As plants are self-oxygenating, installation of pumps and air filters is unnecessary. Use of thermometer, reflector and hood is optional.

Shaping the Scene

Whether you are filling a tank or a single plant bottle, don't try too hard to achieve a perfect seascape. Follow a basic plan but plants and rocks place themselves, often with the most pleasing results. Also remember that plants and other objects viewed at certain angles will be magnified by glass and water.

Basically the entire setting evolves from an undulated gravel bottom supported by rock formations. Well-placed rocks, if in proportion, will contribute to the natural beauty of the underwater scene. Irregular water-smoothed rocks look best, but a ledge of flat pieces built up to retain gravel and plants at higher elevations may be more practical. Use them, partially embedded in the gravel, as a foil for massed greenery or for sharing the central viewing area with your handsomest root-type aquatic plant.

Group plantings are showier but a wide variety of plants is not needed. A few kinds with contrasting leaf patterns and shades of greenery can be just as effective.

The tallest plants predominate, so use them for the background and sides to frame lesser vegetation. Bunch-type aquatics are especially useful as fillers. Reserve small, low sprawlers for the fore-

Photographs by Robert C. Baur

The water garden in the cookie jar (left) consists of dwarf sword-plant (*Echinodorus intermedius*), *Vallisneria spiralis* and *Ludwigia*. The bottle (right) contains *Dracaena sanderiana* and *Vallisneria*.

ground. Also, to avoid an underwater jungle, don't grow too many plants.

However, complete the picture with a few floating aquatics. These are mostly rapid growers that will shade vegetation growing below, so use sparingly.

Space permitting, miniature waterlilies and clumps of semi-aquatics may be added to larger aquariums. Sink them in pots in a corner sloped for a pond-side effect. Further embellishment is up to you—coral, shells, driftwood, or plastic pirate's chests, sunken galleons, and ceramic mermaids. Driftwood is a natural accompaniment but unless waterlogged (or weighted down with lead fishing sinkers) will float to the surface. Note that any object detracting from the artistic simplicity of the planting should be avoided.

Planting the Multi-galloned Container

Slope the gravel backward and to the sides. A 2-inch depth will be enough for most root plants, but it may vary from 4 inches at the deepest point to an inch in front, where small plants are to be placed. As gravel is inclined to become flat in water, retain steeper slopes with rocks, then add more gravel if needed.

After firming the gravel by hand, place a sheet of clean paper over the surface. This will prevent the bottom from shifting when water is poured in. To make planting easier, fill the tank only halfway.

Remove the paper, then place the feature and background plants first. Carefully wash each plant, prune broken roots and dead matter and trim leaves so they will float freely.

Position root-type plants by holding them firmly above the crown and press downward into the gravel. Then push sideways into place. Otherwise roots will be difficult to cover and buoyant plants will surface. Additional small stones or gravel will help to hold unruly plants down. The crown, however, must not be covered as growth will be impaired. Fill in with other root or bunch plants which are weighted with lead strips, or poke the stem tips into the gravel. Keep smaller plants to the fore, and fill the tank with water before adding floating vegetation.

Pots containing waterlily roots and other marginal bog plants should be filled with heavy clay soil and thoroughly saturated before being placed in the aquarium. Set the largest container-grown or most water-demanding plants at the bottom, but build up a slope with flat stones or coarse gravel for smaller or less amphibious ones. The crowns of semi-aquatics should be raised above the surface. Finally, conceal pots from the viewing side with flat stones or underwater vegetation.

Aquatic Bottle

How to plant a tall, tapered bottle, 11 inches tall, 2½ inches in diameter, with a ¾-inch opening: Pour in 1½ inches of cleanly washed gravel through a plastic tube and funnel. Half fill the bottle with water before inserting a 6-inch tall *Vallisneria*. Poke it through the opening, root first, and push it into the gravel with a wooden dowel. If the bottle opening is large enough, work with two slender dowels, one for holding the plant in place and the other for pushing gravel over the roots.

Always size the plant first by holding it against the outside glass, then trim off leaves that will be too long for the bottle. Caution: don't let plants dry out before planting; keep them in moisture-tight plastic bags until needed.

For contrast add a *Cabomba* cutting or similarly graceful bunch-type aquatic having foliage that differs from the tall slender *Vallisneria*. Poke the former into the gravel and add another cutting or more gravel if you think it is needed. Drop in a pebble or two or an interesting shell before filling to the top with water.

These minute aquatic gardens take up little space. Several similar bottles or ones with different shapes—and containing various kinds of plants, may be displayed in half the room and weight needed for a tank aquarium.

Maintenance

Post planting care involves cleaning, pruning and an occasional addition of aged tap water. The usual terrarium instruments will do the work, but if the container opening is too small for scissors, excess leaves should be snared and twisted loose with a hooked wire or similar tool. Entire plants can be removed by hooking the wire to the crown or stem and pulling them through the opening root first. Where roots have become entwined, hold adjacent plants in place with a dowel.

Algae is the aquatic gardener's greatest concern. Most green algae is caused by strong natural light, so keep tanks or bottles away from direct sun—and clean regularly. Exclusive use of artificial light is another way to check algae. They may also be retarded by chemical additives, which should be used strictly according to label directions.

The common fuzzy algae that form on the glass and frequently cover rocks and plants is easily scraped with a razor blade or wiped away with a wire cloth. Other forms like the filamentous green algae with threadlike streamers should be snared or rolled on a wire. They are often discouraged by slightly acid water. Blue-green algae are usually due to an overabundance of nutrients. Remedy: reduced light and rapid-growing plants which will exhaust the excess nitrogen.

Brownish algae (diatoms) may spread in crusted layers in dimly lit corners.

Give better light. Green water ("pea soup") is caused by free-floating microscopic algae. Provide fresh water and reduced light. Finally, some algae can be decorative, too. One of the most attractive is stonewort (*Nitella*), a floating plant frequently seen in breeding tanks.

Snails help keep foliage free of algae and consume unhealthy leaves but their prolific breeding habits outweigh their usefulness. (Possible exception for small containers: the attractive small reddish ramshorn snail, *Helisoma nigricans.*) Inspect new plants of doubtful origin for snail eggs, which are gelatinous, and rinse carefully before adding to the aquarium. A quicker method is to immerse suspect plants briefly in a weak solution of hydrated lime. A high water acidity may also control snails.

Plants

A fairly extensive variety of plants is available by mail from aquatic nurseries and often from local stores where tropical fish are sold. The choice depends primarily on the type of containers you plan to use. The plants mentioned here, which are easy to obtain and to grow, are separated into three groups.

ROOT - TYPE (SINGLE - ROOT) AQUATICS are the most popular because of their striking appearance and the feeling of permanence they give. The showy leaves make these plants invaluable for background and feature plantings. Best known kinds include lace plants (*Aponogeton*), sword plants (*Echinodorus*), *Cryptocoryne* species, arrowheads (*Sagittaria*) and tape grasses (*Vallisneria*).

Let's look at the tape grasses first. They have long ribbon-like leaves and small compact roots, and can be planted close together. Don't combine them with arrowheads, much more robust plants of the same general appearance.

The most popular root-type aquatic is a tape grass known as eel or channel grass, *Vallisneria spiralis*. It eventually grows about 18 inches tall. A form with spirally twisted leaves, *V. s. tortifolia*, reaches 12 inches and is a handsome

This water garden is planted with the graceful water feather and green hygro.

Wine bottle becomes water garden. This bottle contains vallisneria and water feather, a form of *Myriophyllum.*

plant. The jungle vallisneria *(V. gigantea),* growing to 4 or 5 feet, is suitable only in the largest tanks.

Arrowheads grow vigorously to the surface. One that is good, in small containers, however, is needle sag (*Sagittaria subulata pusilla*). The height is about 8 inches, and the leaves are narrow.

Sword plants are a varied group with large leaves. The one known in the trade as *Echinodorus intermedius* is a better sort for small aquatic gardens. Melon sword (*E. longistylis*) has long stems and needs a deep container. Several other large-growing species are available.

Lace plants, which also become sizable, are best used in a multi-gallon tank. They grow from a bulbous root, are dormant in winter and do best in cooler water. Madagascar lace plant (*Aponogeton fenestralis*) is the most celebrated species. Its leaves have a striking latticework appearance.

The genus *Cryptocoryne,* which has no common name, has become well represented in aquatic gardens in recent years. It is a group of bog dwellers which live above and below the water. Foliage is attractive and plants tolerate low light. *C. beckettii* (*cordata* of the trade) has narrow leaves and grows to 6 inches. *C. nevillii* is smaller.

Two other root-type aquatics worth a mention: dwarf Japanese rush (*Acorus gramineus pusillus*), attractive, small and slow growing; hair grass (*Eleocharis acicularis*), to 5 inches, with very thin leaves—plant in clumps.

BUNCH-TYPE AQUATICS are a varied group and make dependable fillers. Their long trailing stems may be trained for tank plantings or trimmed for smaller containers. Leaves, flowers and roots appear at stem joints or nodes. Plants propagate easily from cuttings. Aerial leaves often surface; they have a shiny coating which protects them from dehydration. Here a few of the main bunch types.

Bacopa caroliniana (amplexicaulis) resembles an underwater sedum but is botanically more akin to the snapdragon. It is a sturdy plant with fleshy oval leaves and looks best in groups. Washington-grass (*Cabomba aquatica*), having graceful feathery foliage, is for cool water where light is abundant. Goldfish weeds (*Elodea* or *Anacharis*) perform best in cooler water inhabited by goldfish. Fast growers, some may attain several foot lengths. *Hygrophila* is another hardy rapid grower.

Ludwigia natans is a bog plant of the southern United States and Mexico, and is the best species of its genus for aquatic gardens. Red leaf color may be encouraged with plenty of light, otherwise new foliage is pale green. Some plants die down in winter.

Water-milfoils (*Myriophyllum*) are represented by several species. *M. brasiliense* (*prosperpinacoides*), sometimes called parrot's feather, is a bushy plant adjusting more readily to aquariums than its kin. Water-wisteria (*Synnema triflorum*) produces uniquely different leaf patterns upon the same stem. A native of the Orient, it is associated with rice paddies there. Another bunch-type aquatic is the tall-growing *Limnophila* (*Ambulia*), which does not respond to hard water.

FLOATING PLANTS are surface kinds tethered on long stems to roots embedded in the gravel or those that float entirely free. Among the best known is water-lettuce (*Pistia stratiotes*), which clogs inland waterways of the Deep South. It thrives on heat and humidity. Also familiar are the duckweeds (*Lemna*), of which *L. minor*, *L. gibbosa* and *L. trisulca* are rapid growers in need of frequent thinning.

Water sprite (*Ceratopteris thalictroides*) is an aquatic fern from the Old World tropics and has narrow or broad leaves. Mature plants last only a year but reproduce generously. *Salvinia natans*, another floating fern but one from a cooler climate, has heart-shaped foliage. Crystal-wort (*Riccia fluitans*), a floating liverwort grows into dense mats. *Nitella flexilis*, which has a light feathery appearance, is actually a highly developed branching alga.

Miniature waterlilies (*Nymphaea*) rank highest in beauty among the floaters. Grow them in 6-inch pots of heavy garden soil and reserve them for larger tanks. 'Margaret Mary', which has pale blue flowers with yellow centers, is a small-padded tropical. 'Dorothy Lamour', another diminutive charmer, may be grown under lamps or five hours of daily sunlight.

MARGINAL PLANTS deserve a brief mention. Technically, floating and submerged plants are the only true aquatics, but the term generally embraces marsh kinds that grow in mud or are rooted in water. Some make attractive pot plants to display alongside water gardens or may be incorporated into them.

Apart from several of the taller insectivorous species, appropriate semi-aquatics include: arrowhead (*Sagittaria latifolia*); sensitive fern (*Onoclea sensibilis*); blue flag (*Iris versicolor*); sweet flag (*Acorus calamus*); Chinese-evergreen (*Aglaonema modestum*); *Dracaena sanderiana*; horsetail (*Equisetum*); pickerel weed (*Pontederia cordata*); and even sphagnum moss.

Method to follow when planting a water garden in a bottle. Use a long wooden dowel to help slip the plant, roots first, through the narrow opening of the bottle. The plant being inserted is corkscrew vallisneria. Companion plants include green hygro (*Hygrophila*) and water feather (a form of *Myriophyllum*).

Special ideas for . . .

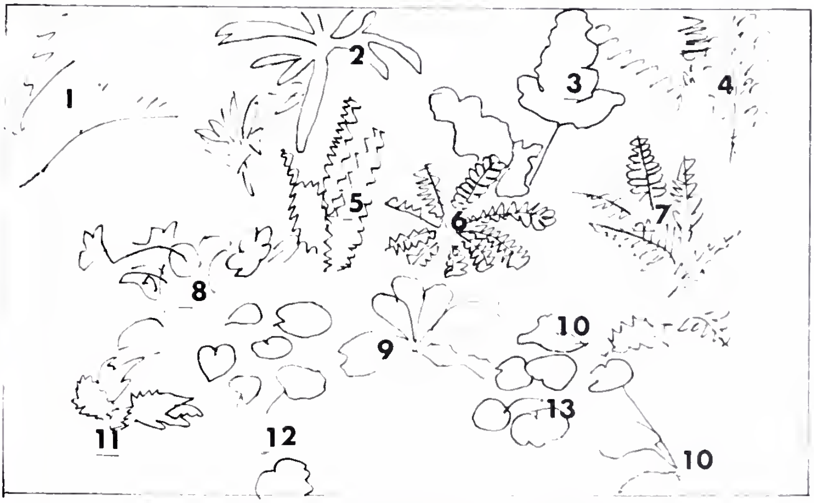
TERRARIUM GARDENS

Photographs by Brenda Weisman

A plant lover's delight is this rock garden-within-a-terrarium created by Sally Freedman of the Brooklyn Botanic Garden. The tall plant that dominates the skyline (above) is the serrated mapleleaf begonia (*Begonia richardsiana*). The fern (left of the begonia) is *Adiantum tenerum 'wrightii'*. **Right:** A section of the terrarium. Plants include:

1 *Codonanthe carnosa devoseana*
2 *Begonia boweri*
3 African-violet 'Pixie Blue'
4 *Aeschynanthus nummularius*
5 *Sinningia* 'White Sprite'
6 *Episcia cupreata* 'Canal Zone'
7 *Episcia cupreata* 'Acajou'
8 *Acorus gramineus nanus*

Charles Marden Fitch



A tropical garden within a terrarium created by Charles Marden Fitch. In a month or so the plants will have to be thinned to prevent the garden from becoming a jungle. The plants include: 1 *Pilea microphylla;* 2 *Podocarpus macrophyllus* (tip cutting); 3 *Polypodium aureum* 'Mandaianum' (sporeling); 4 *Asparagus retrofractus*; 5 *Nephrolepis cordifolia* 'Duffii'; 6 *Biophytum sensitivum*; 7 *Polystichum tsus-simense;* 8 Miniature *Saintpaulia* hybrid; 9 *Gesneria cuneifolia* var. *quebradillas;* 10 *Sinningia* 'Cindy-Ella'; 11 *Begonia prismatocarpa;* 12 *Saxifraga stolonifera;* 13 *Saxifraga stolonifera* 'Tricolor'.

Books, magazines and other publications . . .

FOR FURTHER READING

Brenda Weisman

Terrariums and Miniature Gardens, edited by Kathryn Arthurs for Sunset Books, Lane Book Company, Menlo Park, California, 1973. Soft cover.

A good beginner's reference.

Gardens in Glass Containers by Robert C. Baur, Hearthside Press, New York, 1970.

Current trends in glass gardens. Plants and supplies listed and keyed to main source list.

Enjoy Planting Your Aquarium by William Dewhurst, M.D. The Pet Library Ltd., Sternco Industries, 600 S. 4th St., Harrison, New Jersey.

The Apartment Gardener by Florence and Stanley Dworkin. Signet Books, New York, 1974. Soft cover.

A general house plant book of practical value for the beginner.

Fun With Terrarium Gardening by Virginie and George Elbert. Crown Publishers, New York, 1973. Hard and soft cover editions.

An excellent treatment by two creative people. Extensive source lists.

The Indoor Light Gardening Book by George A. Elbert. Crown Publishers, New York, 1973.

A reference of value for even the most specialized grower. Exceptional, extensive source lists.

The Terrarium Book by Charles M. Evans, with Roberta Lee Pliner. Random House, New York, 1973. Hard and soft cover editions.

The technicalities of terrarium preparation.

The Complete Book of House Plants by Charles Marden Fitch. Hawthorn Books, New York, 1972.

Practical growing experience shines throughout this book. Extensive source lists.

The Complete Book of Terrariums by Charles Marden Fitch. Hawthorn Books, New York, 1974.

More good advice from a seasoned grower. Source lists.

Ferns to Know and Grow by F. Gordon Foster. Hawthorn Books, New York, 1971. Also in soft cover.

An indispensable guide.

All About House Plants by Montague Free. Doubleday and Co., Garden City, New York, 1946.

The forerunner of the current crop of general house plant books and still one of the best no-nonsense references.

Tropical Fish by Douglas Gohm, Hamlyn Publishing Group, Ltd., Feltham, Middlesex, Great Britain.

Aquatic plants.

Exotic Plant Manual by Alfred Byrd Graf, Roehrs Co., Rutherford, New Jersey, 1970.

Indispensable reference for the serious plantsman. Editions for every pocketbook under similar names.

Introduction to Terrariums by Barbara Joan Grubman. Popular Library, New York, 1972. Soft cover.

A refreshing approach, particularly for the timid beginner. The author obviously follows her own rule to relax and enjoy terrariums.

Terrariums by John Hoke. Franklin Watts, New York, 1972.

Good for schools and nature study groups.

Exotic Aquarium Fishes by William T. Innes. 19th edition, revised, edited by

Helen Simkatis, Metaframe Corporation, Maywood, New Jersey, 1966. Plants, too. One of the best.

Bottle Gardens by Jack Kramer. Lancer Books, New York, 1973. Soft cover.

Bromeliads, The Colorful House Plants by Jack Kramer. Van Nostrand, New York, 1965. Out of print.
One of the few practical references on the subject.

The Complete Book of Terrarium Gardening by Jack Kramer. Charles Scribner's, 1974.
Very readable and beautifully illustrated. Source lists.

Gardens Under Glass: The Miniature Greenhouse in a Bottle, Bowl or Dish by Jack Kramer. Simon and Schuster, New York, 1969.
One of the first of the modern terrarium books. A wealth of ideas for the home grower.

Pocket Encyclopedia of Cacti and Succulents in Color by Edgar and Brian Lamb. Macmillan Co., New York, 1970.
A valuable, comprehensive guide by two British authorities.

The Complete Book of Gardening Under Lights by Elvin McDonald. Doubleday and Co., Garden City, New York, 1965; also, Popular Library, New York, 1974 (soft cover).

The House Plant Answer Book by Elvin McDonald. Popular Library, New York, 1975. Soft cover.
Practical, readable and informative. Sources and publications.

Little Plants for Small Places by Elvin McDonald. Popular Library, New York, 1974. Soft cover.
Engaging material here for the terrarium grower.

The World Book of House Plants by Elvin McDonald. Popular Library, New York, 1972. Paperback.
Outstanding, warmly personal reference by a dedicated plantsman.

Home Orchid Growing by Rebecca Northen. Third edition, revised, Van Nostrand-Reinhold, New York, 1970. One of the best practical guides.

The World of Carnivorous Plants by James and Patricia Ann Pietropaolo. R. J. Stoneridge, Shortsville, New York, 1974. Soft cover.
Scholarly, readable and practical. Quite an accomplishment for one book.

There are also relevant Handbooks in the Brooklyn Botanic Garden series—*House Plants, Succulents, African-Violets and Their Relatives, Miniature Gardens, A House Plant Primer* and *Gardening Under Artificial Light*. See back cover of this Handbook for more information.

Several periodicals are worth a special mention. PLANTS ALIVE, appearing ten times a year, often has pertinent articles on suitable terrarium plants. Address: 319 N.E. 45th, Seattle, Washington 98105.

Others of interest are the quarterly "Carnivorous Plant Newsletter" (particulars from D. E. Schnell, Rte. 4, Box 275B, Statesville, North Carolina 28677, or J. A. Mazrimas, 329 Helen Way, Livermore, California 94550. For information on "Terrarium Topics," a newsletter appearing six times a year, write R. C. Baur, 57 Wolfpit Ave., Norwalk, Connecticut 06851. "Light Garden," a bimonthly, is published by the Indoor Light Gardening Society of America (128 W. 58th St., New York, N.Y. 10019). Other, more specialized societies also issue useful bulletins. For a list of addresses, see page 82.

Once the bug bites . . .

PLANT SOCIETIES

TERRARIUM buffs have a number of plant societies they can turn to for detailed information on their favorite group of miniatures. The societies, which are membership organizations supported by dues, issue journals or other periodicals, and in some cases have seed exchange lists. A number of them hold annual meetings, too. The opportunity that such clan gatherings present for new growers to bend the ears of the old pros is usually well worth the price of admission. As in most areas of horticulture, the experienced growers are ready, willing and often anxious to share their brown-thumb knowledge with newcomers. Here's a Wardian case full of the major societies:

African Violet Society of America, Box 1326, Knoxville, Tennessee 37901

American Begonia Society, 10331 S. Colima Rd., Whittier, California 90604

American Fern Society, c/o Dr. Dean P. Whittier, Department of Biology, Vanderbilt University, Nashville, Tennessee 37235

American Gesneria Society, 11983 Darlington Ave., Los Angeles, California 90049

American Gloxinia and Gesneriad Society, Box 174, New Milford, Connecticut 06776

American Orchid Society, Botanical Museum of Harvard University, Cambridge, Massachusetts 02138

American Rock Garden Society, Milton S. Mulloy, Secretary, 90 Pierpont Rd., Waterbury, Connecticut 06705

Bromeliad Society, Box 3279, Santa Monica, California 90403

Cactus and Succulent Society of America, 1593 Las Canaos Rd., Santa Barbara, California 93105

Indoor Light Gardening Society of America, 423 Powell Dr., Bay Village, Ohio 44140

Los Angeles International Fern Society, 2423 Burritt Ave., Redondo Beach, California 90278

New England Wild Flower Society, Hemenway Rd., Framingham, Massachusetts 01701

Saintpaulia International, Box 549, Knoxville, Tennessee 37901

. . . and, of course, The Terrarium Association, 57 Wolfpit Ave., Norwalk, Connecticut 06851

George Taloumis

Fittonia can be the star attraction of a terrarium. As the plant fills the jar, some pruning will be required.

This "hour glass" terrarium gives two sections for planting. Just one of many designs now available from commercial sources.

George Taloumis

Where to find them . . .

SUPPLIES FOR THE TERRARIUM

HOME GARDENERS in most parts of the country should have little trouble obtaining ready-made terrariums and supplies locally. However, if you do, or if you would like a wider range to choose from, this list may come in handy. There is no charge for catalogs or lists unless mentioned.

A & N Terrarium Tool Co., 5979 Hosta Lane, San Jose, California 95124. Terrarium and bottle tools. Catalog.

Brookstone Co., Peterborough, New Hampshire 03458. Unusual tools, pruners and plant tongs. Catalog.

Christen, Inc., 59 Branch St., St. Louis, Missouri 63147. Extensive line of glass and plastic terrariums and kits. Widely available, but write for local distributors.

Corning Glass Works, Consumer Products Division, 715 Fifth Ave., New York, N.Y. 10022. Creative Glassware(T)—kitchen glassware suited for unusual terrariums. Commonly available in hardware and department stores.

Edelman & Goldstein Designs, Ltd., 272 W. 86th St., New York, N.Y. 10024. Plastic terrariums and cubes. Wholesale only. Write for distributors.

Bernard D. Greeson, 3548 N. Cramer, Milwaukee, Wisconsin 53211. Supplies. List 10¢.

The House Plant Corner, Box 165, Oxford, Maryland 21654. Supplies and equipment. Send 25¢ in stamps for catalog.

M & G Sheet Metal Co., 313 Van Sinderen Ave., Brooklyn, New York 11207. Unusual glass and brass terrariums and boxes. Expensive but beautiful.

O'Dell Manufacturing Inc., P.O. Box 1426, 1930 S. 23rd St., Saginaw, Michigan 48605. Attractive line of aquariums and terrariums in unusual shapes, including L-shapes and octagons, or ones tailored to order. Write for information or retail distributors.

Libbey Glass Division, Owens-Illinois, Toledo, Ohio 43601. Libbey Inkeepers(T). Glass kitchen containers. Widely distributed in hardware and department stores.

The Pilgrim Glass Corporation, Moonachie, New Jersey 07074. Kitchen Chemistry(T) glassware. Unusually extensive line. Commonly available.

Rockline, Box 247, Rockfield, Wisconsin 53077. Extensive assortment of terrariums and kits in different shapes. Widely distributed. Write for retail outlet.

South Shore Floral Co., 1050 Quentin Pl., Woodmere, New York 11598. Send for list.

Where to find them . . .

SOURCES FOR TERRARIUM PLANTS

Sally Freedman

THE NAMES of nurseries mentioned below were in most instances suggested by our contributors and are presented here strictly as a convenience to readers. Unless stated, the firms ship and there is no charge for catalogs. For additional indoor plant sources see the lists in Brooklyn Botanic Garden Handbooks No. 43 (*Succulents*) and No. 70 (*A House Plant Primer*).

Abbey Garden, 176 Toro Canyon Rd., Carpinteria, California 93013. Coded to indicate growth habit or outstanding characteristics of cacti, succulents, South African bulbs and some small cycads. Catalog 50¢.

Alberts & Merkel Bros. Inc., 2210 S. Federal Hwy., Boynton Beach, Florida 33435. Orchids, bromeliads, gesneriads, ferns, foliage plants, supplies. Catalog 50¢.

Arthur Eames Allgrove, Box 459, Wilmington, Massachusetts 01887. Woodland plants, supplies. Catalog 50¢.

Alpenglow Gardens, 13328 King George Highway, North Surrey, B.C., Canada. Wildflowers, hardy alpines, perennials, dwarf and slow-growing conifers. Catalog 35¢.

Armstrong Associates, Inc., Box 94, Kennebunk, Maine 04043 (also Box 127, Basking Ridge, New Jersey 07920). Insectivorous plants. Catalog 25¢.

M. J. Bates Co., 7911 U.S. 301, Ellenton, Florida 33532. Orchids.

Bee Fork Water Gardens, Bunker, Missouri 63629. Good drawings and descriptions of aquatic plants.

Buell's Greenhouses, Eastford, Connecticut 06242. Gesneriads. Catalog 25¢ and a business-size, self-addressed envelope.

Cactus by Mueller, 10411 Rosedale Hwy., Bakersfield, California 93308. Catalog 10¢.

Cornelison's Bromeliad Nursery, 225 San Bernardino St., N. Fort Meyers, Florida 33903. Send stamp for listings.

Desert Botanical Garden, Box 5415, Phoenix, Arizona 85010. Seed of illustrated plants at 50¢ a packet.

L. Easterbrook Greenhouses, 10 Craig St., Butler, Ohio 44822. Begonias and other house plants suitable for terrariums. Cultural information for miniature and other gesneriads. Catalog $1.00.

Edelweiss Gardens, 54 Robbinsville-Allentown Rd., Box 66R, Robbinsville, New Jersey 08691. Begonias, bromeliads, insectivorous plants, gesneriads, ferns, orchids and house plants for terrariums. Catalog 35¢.

Fischer Greenhouses, Linwood, New Jersey 08221. Miniature African-violets and other gesneriads. Catalog 15¢.

Gardens of the Blue Ridge, Ashford, McDowell County, North Carolina 28603. Native ferns and wildflowers.

Grigsby Cactus Gardens, 2326 Bella Vista Drive, Vista, California 92083. Catalog 50¢.

Greenland Flower Shop, Port Matilda, Pennsylvania 16870. House plants. Catalog 25¢.

Henrietta's Nursery, 1345 N. Brawley Ave., Fresno, California 93705. Catalog 25¢. Cacti and succulents.

Ilgenfritz Orchids, Blossom Lane, Box 1114, Monroe, Michigan 48161. Description and culture of terrestrial and miniature epiphytic orchids. Catalog $2.00.

J & L Orchids, 20 Sherwood Rd., Easton, Connecticut 06612. Botanical orchids, hybrids, select species.

Johnson Cactus Gardens, 2735 Olive Hill Rd., Fallbrook, California 92028. Catalog 25¢.

Kartuz Greenhouses, 92 Chestnut St., Wilmington, Massachusetts 01887. Gesneriads, begonias, other exotic plants from the hands of a well-known breeder. Catalog 50¢.

Keil Bros., 220-15 Horace Harding Blvd., Springfield Blvd. & L.I. Expwy., Bayside, New York 11364. Wide selection of house plants suitable for terrariums. No mail order.

Lager & Hurrell, 426 Morris Ave., Summit, New Jersey 07901. Orchids, with cultural notes. Catalog $2.00.

Lauray of Salisbury, Undermountain Rd., Salisbury, Connecticut 06068. Gesneriads, begonias, cacti and other succulents. Catalog 50¢.

Logee's Greenhouses, 55 North St., Danielson, Connecticut 06239. Begonias, ferns, mosses, cacti and other succulents. Catalog $1.00.

Lyndon Lyon, Dolgeville, New York 13329. Miniature and trailing African-violets and other gesneriads.

Rod McClellan Co., 1450 El Camino Real, S. San Francisco, California 94080. Miniatures and special hybrid orchids, supplies. Catalog $1.00.

McComb's Greenhouses, Greenacres, Washington 99016. Miscellaneous house plants. Catalog 50¢.

Merry Gardens, Camden, Maine 04843. Begonias, cacti, ferns, mosses, gesneriads, foliage house plants. Catalog 50¢.

Norvell Greenhouses, Box 73, Greenacres, Washington 99016. House plants. Catalog 25¢.

Peter Pauls Nurseries, Route 4, Canandaigua, New York 14424. Catalog includes plant culture and list of insectivorous plants, seed, supplies (living sphagnum moss).

The Plant Room, 6373 Trafalgar Rd., Hornby, Ontario, Canada. Miscellaneous house plants.

The Rock Garden, Litchfield, Maine 04350. Hardy perennials, dwarf, slow growing shrubs and conifers. Catalog 35¢.

Three Springs Fisheries, Lilypons, Maryland 21717. Aquatic plants. Well illustrated catalog $1.00.

Tinari Greenhouses, 2325 Valley Rd., Huntington Valley, Pennsylvania 19006. African-violets, supplies. Catalog 25¢.

Tropical Paradise Greenhouses, Overland Park, Kansas 66104. General house plants. Catalog 50¢.

Whistling Hill Greenhouse, Box 27, Hamburg, New York 14075. Gesneriads.

Wyrtzen Exotic Plants, 165 Bryant Ave., Floral Park, New York 11001. Miniature gesneriads and begonias. No mail order.

Robert C. Baur

A bird's-nest fern (*Asplenium nidus*) in an old vinegar jug.

The World's Best Illustrated Garden And Horticultural Handbooks

Each One A Complete, Concise Manual, 64 to 112 Pages, Printed on Quality Book Paper
(These Handbooks are separate editions of special feature issues of PLANTS & GARDENS)

10. Rock Gardens **$1.50**
125 pictures of the best; ideas on design, construction and care; appropriate plants

13. Dwarfed Potted Trees— The Bonsai of Japan **$1.50**
answers important questions on selection, training, pruning, care; over 100 pictures

14. Vines **$1.50**

19. Flower Arrangement **$1.50**
how to use basic rules of color and design, making attractive containers, decorations

20. Soils **$1.50**
kinds of soil; how to improve and maintain

22. Broad-leaved Evergreens **$1.50**
culture and use of hollies, rhododendrons, camellias, others; newly updated

23. Mulches **$1.50**
best kinds to use in various regions, when and how to apply, new materials available

24. Propagation **$1.50**
seeds, cuttings, layering, grafting

25. 100 Finest Trees and Shrubs **$1.50**
descriptions; culture, hardiness, landscaping

26. Gardening in Containers **$1.50**
on roofs, terraces, difficult sites; city gardens; hanging baskets, window boxes

27. Handbook on Herbs **$1.50**
basic kinds, culture, uses; well illustrated

28. Pruning Handbook **$1.50**
methods and effects of pruning woody ornamentals, fruits and many tender plants

29. Handbook on Gardening **$1.50**
everything for beginning gardeners, experienced gardeners, too; how to select and care for plants; scores of "how to" pictures

31. Bulbs **$1.50**
when and how to plant all kinds of bulbs; best uses in the garden; indoor forcing

33. Gardens of Western Europe **$1.50**
a copiously illustrated traveler's aid

34. Biological Control of Plants Pests **$1.50**
by parasites, predators, other natural means

36. Trained and Sculptured Plants **$1.50**
special methods, pruning; many pictures

37. Japanese Gardens and Miniature Landscapes **$1.50**
old and new gardens and how they apply to Western horticulture

38. Gardening with Wildflowers **$1.50**
how to know and grow American wildflowers

39. The Environment: and the Home Gardener **$1.50**

40. House Plants **$1.50**
superior kinds, uses, care; well illustrated

41. Flowering Trees **$1.50**
crab-apples, dogwoods, magnolias, cherries, others; how to select and grow them

42. Greenhouse Handbook for the Amateur **$1.50**

43. Succulents **$1.50**
cactus, flowering "stones," desert plants; culture, nursery sources; 4 pages in color

44. Flowering Shrubs **$1.50**
use, care and bloom succession of 200 kinds; selections for different parts of the U.S.

45. Garden Structures **$1.50**
walks and paths, fences, walls, paved terraces, steps, garden pools, benches

46. Dye Plants and Dyeing **$1.50**
a handbook on dyes derived from plants; how to use them for dyeing yarns and textiles; many recipes; 4 pages in color

47. Dwarf Conifers **$1.50**

48. Roses **$1.50**

49. Creative Ideas in Garden Design **$1.50**
83 fine photographs of well-designed gardens for outdoor living and for viewing

50. Garden Pests **$1.50**

51. Bonsai: Special Techniques **$1.50**
classic styles; ways to prune and wire; winter care; soil; 8 pages in color

53. African-Violets and Relatives **$1.50**
gloxinias, episcias, columneas, too; miniatures; care, propagation; picture dictionary

54. Handbook on Orchids **$1.50**

55. America's Garden Heritage **$1.50**
explorers, plantsmen and gardens of yesterday. Origins of American Horticulture

56. Summer Flowers for Continuing Bloom **$1.50**
choice annuals, perennials, shrubs and trees

57. Japanese Herbs and Their Uses **$1.50**
picture dictionary of uncommon kinds; recipes from Japan; flower arrangements

58. Miniature Gardens **$1.50**
diminutive landscapes and tiny plants; sink, trough and portable rock gardens

59. Ferns **$1.50**
kinds, care and uses; 4 pages of color

60. Handbook on Conifers **$1.50**
choice evergreen trees for year-round beauty

61. Gardening in the Shade **$1.50**

62. Gardening under Artificial Light **$1.50**

63. 1200 Trees and Shrubs— Where to Buy Them **$1.50**
a uniquely useful buyer's guide, with brief descriptions of every plant; nurseries

64. American Gardens—Traveler's Guide **$1.50**
information on more than 200 gardens in the U.S. and Canada; directions, photographs

65. Tree and Shrub Forms—Their Landscape Use **$1.50**
how to plant trees and shrubs to bring out their best qualities

66. Rhododendrons and Their Relatives **$1.50**
Best choices for various parts of the U.S. Azaleas, heather, mountain laurel, others

67. Fruit Trees and Shrubs **$1.50**

68. Herbs and Their Ornamental Uses **$1.50**
The most attractive herbs for garden and kitchen use. Companion Handbook to #27

69. The Home Vegetable Garden **$1.50**

70. House Plant Primer **$1.50**
A companion Handbook to #40

71. Home Lawn Handbook **$1.50**

72. Natural Plant Dyeing **$1.50**
A complement to Handbook #46

73. Weed Control **$1.50**

74. Annuals **$1.50**

75. Breeding Plants for Home and Garden **$1.50**

76. Dried Flower Designs **$1.50**

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l. 31 No. 4
(Winter 1975-76)

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

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Photographs by Philip B. Mullan

Above: Three authorities on the art of bonsai at the Brooklyn Botanic Garden on July 8, 1975. From left to right: Masakuni Kawasumi, Kyuzo Murata, both of Japan, and Frank Okamura, the Brooklyn Botanic Garden's bonsai man. "The Spirit of Bonsai" on page 4 is adapted from Kyuzo Murata's lecture at the Garden last July. **Left:** George Avery, Director-emeritus of the Brooklyn Botanic Garden, and a venerable specimen of the scholar tree (*Sophora japonica*), planted at the Garden in 1924. Beginning on page 8, Dr. Avery expresses some of his thoughts and opinions on a variety of subjects, including botanic gardens today and the place of ornamental plants in both private and public gardens.

LETTER FROM THE BROOKLYN BOTANIC GARDEN

The first issue of PLANTS & GARDENS each year is customarily devoted to a summing up of recent horticultural news, and 1976 is no exception to the practice started hy Dr. George S. Avery some thirty-one years ago when he conceived the idea of the publication. It has evolved over the more than three decades, as have all periodicals devoted to gardening, but the premise of providing concise, authoritative, down-to-soil information in inexpensive editions within the reach of everyone, remains the same. At this time we take special pleasure in thanking contributors and fellow puhlications for making this 124th issue of P&G possible.

The practice every fourth issue is to reprint articles of more-than-passing interest that have appeared in other periodicals in the previous twelve months, but this year readers will notice more articles which are seeing the light of day for the first time. Endangered species of plants have lately become the subject of much concern to the wider community, and we especially appreciate the effort that Jane Herrman of the Instruction Department has made to tell us what has actually been done on the state level to protect our diminishing wildflowers. It is a bleak story, Miss Herrman reports, and some species are bound to disappear under a drying breeze of rhetoric and the inefficient machinery of protection, not to mention the bulldozer. (For a much tarter view, see Janet Hopson Weinherg's article, "Botanocrats & the Fading Flora," in *Science News*, Vol. 108, pp. 92-95.)

While talking about species and briefly noting that the singular and plural have the same spelling (specie is currency), a word should be said about botanical names. New gardeners are often chary of them—unnecessarily so. No one seems to have trouble saying ***Chrysanthemum*** or ***Rhododendron***, and these two botanical names are more difficult than most. The important point is precision, for common names vary but botanical ones (in theory at least) are always the same. Mayflower is a good example because it has been applied to more than two dozen kinds of plants, depending on the part of the country one hails from.

Certain species, we are obliged to report, are not vanishing at all but are getting more and more common, at least in their garden forms. One of them is the honey locust (*Gleditsia triacanthos*), which has been widely planted in recent years—but upon which there has been little word concerning performance in different geographical regions of the United States. It is hoped that P&G can occasionally bring together such data on well known ornamental trees. See pages 19-25 for information on the honey locust.

Finally, the hot, roasted-sidewalk days of the current spring in New York have provided an unwanted reminder of the ephemeral display character of tree and shrub blossoms. Some of the single-flowered crabapples and ornamental cherries opened and closed the floral shop in just three days. That's a short time if one has been waiting 362 days for them. How much better, in the home garden, it would be to select trees and shrubs for interesting bark or foliage or growth habit, in addition to flowers. These can he appreciated year round in many instances and give as much pleasure in September as in May.

Good gardening in the coming season.

Frederick McGourty, Jr.

Editor

Bonsai's association with the change of seasons and other natural phenomena is far more important than one can imagine . . .

SPIRIT OF BONSAI

Kyuzo Murata

Adapted from a lecture given at the Brooklyn Botanic Garden, July 8, 1975

IT was about fifteen years ago when people all over the world started to understand a word, bonsai. Of course, few enthusiasts knew the word until then, for mostly it was called dwarfed plant, potted tree, or miniature tree. In 1960 a huge-scale bonsai show was staged at the Osaka Expo. I believe Expo really played a major role in promoting the word bonsai to all foreign visitors.

Questions often arose at Expo and later. "What is the definition of bonsai? What is the difference between bonsai and *Hachiuye,* which means potted plant?" The answer is not simple. I usually give the following definition:

Bonsai is a living plant transferred to a pot or tray or on a rock or stone so that it can continue to live semi-permanently. It has not only a natural beauty of the particular plant but the appearance reminds people of something other than the plant itself. It could be a scene, a forest or a part of forest, a lone tree in the field, a seascape, a lake, a river or a stream or a pond. It is also possible that a certain appearance reminds a person of wind blowing over these scenes.

In Japan, the meaning of bonsai is to create a natural scene on the tray, using plants as the main materials. When you take a *Hachiuye,* or potted plant, you can only see "prettiness of the plant or flower." It does not remind you of anything else. It is possible, however, to change the *Hachiuye* into bonsai by using what we call bonsai technique. By adapting the techniques of *Yoseuye* (group planting) and *Ne Tsuranari* (root connecting), we can make the scene look like a forest or part of a forest. *Shakan* or slanting style, will remind you of wind blowing; *Kengai* or cascade style, will remind you of a cliff.

The next question is "Can we add grasses or materials other than plants?" There are many people who believe the grasses or stones or rocks are an important decoration of bonsai. They help improve the appearance of bonsai. In a way I agree with them. I would not say that all kinds of grasses should be employed, but some are quite usable and sometimes they will make fine bonsai. There are certain kinds of grasses or stones that remind one of a grass field, or rocks in rapids or murmuring streams.

At the extreme limit I believe that even tulips or hyacinths can be used with bonsai. Back in the early 1950's I used to see many banana-tree bonsai about 10 inches high, but I do not see them now. In a way I feel sorry that I don't see them anymore in Japan.

The Bonsai Spirit

What I have discussed so far is a general conception in the Japanese bonsai world, and I am sure you are all familiar with the idea. Let us now proceed a little further, a little deeper. The art of bonsai was developed in Japan where there were four seasons, clear water, and clean air all over the country, a 1,500-year-old history with many ancient but unchanging traditions or customs. Among all these things the art of bonsai has grown to be what it is today.

I do not think that bonsai could have developed and survived in the tropical or frigid zone or the desert. Bonsai's association with the change of seasons, mountains, valleys, rivers, waters, lakes, storms, gentle wind, rains, snow, frost,

This Japanese white pine (*Pinus parviflora*) is one of the finest specimens in the Brooklyn Botanic Garden's bonsai collection. It was obtained from Kyuzo Murata.

and many other natural phenomena is far more important than one can imagine. Japan is one of the few fortunate countries that have all of these.

Bonsai should not be a mere sketch of a scene, or a three-dimensional exhibit from a photograph of a scene. It is perfectly all right to use nature as the subject, but the goal should be a sketch which has been refined and trimmed in your mind before you start creating. Only then you can call it an art.

For instance, in Japan, we have the traditional Noh play or classic Japanese dance, which is the product of three-dimensional music and story. In your country you have ballet. If ballet can be defined as a fusion or union of human sensibility and art, then bonsai can be defined as a union of nature and art.

The Noh play or ballet expresses its movement in a relatively short period of time; on the other hand, you can hardly notice the slow growth of bonsai. The object of bonsai is to simulate nature. Nature expresses eternity in very, very slow movement and bonsai demonstrates this concept of the slow process of nature.

When your concept of bonsai comes this far, then you cannot avoid going into the world of *Wabi* or *Sabi*. It is an almost impossible task to try to explain the meaning of these terms because they are concepts of feeling which were created and actually only felt by Japanese people over many, many generations; they were unknown to westerners until recently.

Wabi is a state of mind, or a place, or environment in tea ceremony, or in Haiku. It is a feeling of great simplicity, quiet yet dignified. *Sabi* is a feeling of simplicity and quietness which comes from something that is old and used over and over again. For an instant, picture yourself standing at a corner of Ryoanji's stone garden in Kyoto in the evening, in late autumn in a misty rain. You are viewing the garden; the next moment you close your eyes and are deep in thought. Actually there is nothing in your mind. It is empty, and yet your mind or heart is fulfilled with certain contentment. That feeling is *Wabi*.

(Continued)

I firmly believe the final goal of creating bonsai is to create this feeling of *Wabi*, or *Sabi* in bonsai. This is the ultimate goal of the art of bonsai. I do not have the knowledge to explain the essence of *Wabi*, or *Sabi*, but I cannot help but think that the essence of philosophy is to seek truth, virtue and beauty, and it so happens that these are the essence of bonsai.

The feeling of *Wabi*, or *Sabi*, is something almost stoic which eventually leads us to Zen Buddhism. These are not easy-going feelings; they are very disciplined, quiet but severe. The feelings are common among people who are very religious and people who create bonsai. I think this feeling is love, love for trees, love for human beings.

No Single Technique

Now, let us go back to reality. Bonsai is a strange art wherein one can produce a feeling of the reality of nature by manipulation, over a long period of time, of trees, stones, rocks, trays or pots. And every bonsai is an original. No two are alike. You can never finish or complete the creation of bonsai. It goes on and on forever.

In the art of bonsai, there is no particular school for teaching technique as you have in flower arrangement. This is because we must protect the life of a tree permanently. Limiting the bonsai technique to a certain style is to ignore the physiology of the tree. If you try to enforce your own particular design on the tree without considering its nature, the tree may eventually die. Plant physiology is limited. You need to understand this limitation as you create your bonsai.

Apart from trees in the field or forest, trees in bonsai trays or pots are, I believe, the longest living plants which you help to grow and sustain with love, and which share your joys and sorrows. They say the life span of an average cherry tree in nature is about 120 years, but it is not rare to see much older cherry trees as bonsai. It becomes a sort of religion when you start loving a bonsai which has a much longer life span than your own.

All of you who are actually engaged in the art of bonsai have at one time or another studied under fine bonsai teachers and have mastered the techniques of *Chokkan* or upright style, *Moyogi* or octopus style, *Shakan* or slanting style, and *Kengai* or cascade style, but when it comes to *Nebari*—arranging root systems or branches—you realize that it does not

A noble bonsai in life and death. **Far left:** The bonsai Fudo (*Juniperus chinensis sargentii*), which was obtained from Kyuzo Murata for the Garden's collection in 1970. **Left:** Fudo, in death, is now on display in the Garden's rotunda.

Philip B. Mullan

always work as it is taught.

I have been working with bonsai for the past 60 years, and I still come across problems almost every day—about fertilizer, about soil for planting, about watering, about stones or rocks, about wiring. There is no way to make a fast decision. One sometimes takes several years to arrive at a solution. So, recently I have come to my own conclusion that the most challenging technique in the art of bonsai is to transform a most unnatural-looking tree into a most natural-looking tree.

For instance, there was a famous zelkova which was owned by the late Prime Minister Shigura Yoshida, who happened to be Chairman of Nippon Bonsai Association at the time. This bonsai was created by Mr. Ogata. He had severed the main trunk of the zelkova and created a totally new look. When I first saw it at the annual Kokufukai Exhibition, I laughed, and so did the directors of national museums who attended the exhibition. Several years later it was again exhibited at the Tokyo Olympics and people liked it this time. Some years later it was displayed at another Kokufukai Exhibition, and this time it was recognized as one of the finest bonsai in Japan. It really is a strange looking tree. You would never find such an unnatural-looking tree anywhere in the world, yet it looks exactly like a huge zelkova tree standing alone and strong in the field.

Let me deviate to another example. In a Japanese Kabuki play, a male actor plays the role of a female. We call him Oyama. The audience knows that she is he, but he really acts and looks like a woman. This is an art. The same thing can be said about the art of bonsai.

In Japan and China, we have what we call the art of handwriting, or calligraphy. There are three basic ways of writing *Kanji,* just as in the West there are two basic ways of writing alphabets, capital letters and small letters. I think we can apply the same variation to bonsai. When you try to sketch natural scenery, you may use either capital letters or small letters because the basic goal is the same, but your method of approaching this goal is different.

Fortunately, there is a replica of the Ryoanji Temple Stone Garden at Brooklyn Botanic Garden. For those who have not seen the garden, visit it if you have a chance. Just stand there and watch, if you are tired; close your eyes. I am sure this experience will help you to understand more about bonsai.

AVERY SPEAKING

THE telephone rang, and on the other end a soft, gentle, almost sonorous response came, "Avery speaking." It was a familiar sound to anyone who had been a staff member at the Brooklyn Botanic Garden from 1944 to 1969—the quarter century when the Garden was directed by George S. Avery. The voice was also well known to thousands of friends and supporters of the BBG, for George Avery personalized the Garden and encouraged people across the United States to share his aspirations. A distinguished plant researcher in his own right, past president of the Botanical Society of America, and recipient of many awards, Dr. Avery was responsible for broadening the appeal and support of the Garden so that it became one of the leading institutions of its kind in the world.

Nearly seven years have passed since Dr. Avery's departure for his home near Connecticut College in New London, where he had taught botany before coming to the Botanic Garden. Some of that time has been devoted to personal and pleasurable pursuits that were not possible during his years of service in Brooklyn, but BBG and the wider community are still very much in his thoughts. Here are some of these current reflections for friends of the Garden—old and new.

Why did you come to Brooklyn?

It was a social challenge. I have always been interested in the social aspects of science as well as science for its own sake.

Did you have any regrets about leaving university life?

No, but it is true that colleges and universities provide a stimulating atmosphere in which to work; a person very often has a number of colleagues working in a related field. However, employment in universities is essentially frozen by permanent tenure. As a full professor I had tenure but felt that it wasn't the best thing for a university or an individual. It's important to have turnover in jobs especially when a man is younger and is getting experience. Nothing is more deadly than exposing a person to the same atmosphere for too many years. In my view this is also a weakness in civil-service tenure.

What gave you the greatest pleasure as Director of the Botanic Garden?

Working with people and seeing things happen, not only at the Botanic Garden but in a larger sense to all America—seeing people grow more conscious of their environment. Witness Mr. Average Intelligent Citizen who, a few years ago, had little aesthetic interest in his environment. He has become aware of interrelationships between all forms of life—of the relative balances in nature. This is one of the great developments of our time and it was tremendously satisfying to have a part in it.

What do you regard as the most important quality in leadership?

Asking no one to do anything that the leader himself is unwilling to do. Also, there has to be an interest in something bigger than one's self, an awareness that life as a whole is more important than we are as individuals. The least important word in the English language is "I."

How did your scientific work progress as you got underway with Botanic Garden projects and administrative problems generally?

It lost out as involvement with the Garden grew. I continued scientific work until about 1950 and managed to finish a second book on plant growth hormones in collaboration with a few colleagues. Then I edited two volumes of *Biological Progress* and had a consulting relationship with the Dow Chemical Company for several years, during which time the Botanic Garden received research grant funds from the Company. I developed a few patents for Dow, based on techniques that made use of the plant hormones they were later to produce and market. As I

A conversation with the distinguished Director-emeritus of the Brooklyn Botanic Garden

"The experience of contributing to a botanic garden to help create and maintain living beauty, seems to me a very special privilege—yet one that is open to all."

settled into my Botanic Garden job, there were more and more demands. It just seemed wise not to have ulcers, so outside professional commitments were terminated.

You are known especially for popularizing the scientific aspects of plant science. How did this come about?

Partly through helping to broaden the instruction program at the Garden so it would appeal to a larger number of people. On a wider scale PLANTS & GARDENS, which started publication in 1945, contributed to the idea. The dissemination of special-subject issues as separate editions (Handbooks) having national and international circulation developed about 1950. This I think was the realization of my dream—that the effort we were making to advance horticulture-for-the-layman would become one of the Botanic Garden's greatest opportunities. It was a departure from the traditional approach of botanic gardens, which were more apt to be plant collections for botanists, particularly in Europe but in America as well.

Is the concept of a botanic garden in North America very different from that in Europe?

Well—, the European botanic gardens evolved from the medicinal plant gardens of medieval times. Even today they give less attention to what we in our American garden call ornamental horticulture. Moreover, European botanic gardens are usually associated with tax-supported universities. This very question once came up in conversation with the director of a Swiss garden, when I mentioned something about private support supplementing public support. He said that his garden received no money from private individuals and that, in fact, no one in his country would think of giving to a basically tax-supported garden. I concluded, later, that private generosity in such situations depends on the stage of maturity of a country. First comes the pioneering phase, then a developmental phase. Somewhere along the line great public interest can develop. People want to give of themselves—their personal efforts and their wherewithal—to help make something happen. It seems to me now that a more mature civilization really can't offer much in the way of private support for communal projects. It has to depend on the tax structure. I hope America can somehow continue the tradition of private giving, of living the Golden Rule.

You once said that you never asked anyone to give money toward the support of BBG, yet endowment rose from approximately $1½ million in 1944 to between 5 and 6 million dollars 25 years later. How did this happen?

Well, I did once ask for money. After a delightful conversation and exchange of views, the person said, "I'd rather keep it myself than give it to your institution." Thereafter it seemed better to give people a chance to become interested—a chance for involvement—to want to give of their own volition.

The giving of money, to me, is a spiritual experience. This spirit can only be developed through genuine friendship and involvement in projects that are of interest to the potential donor as well as to the recipient. There has to be a common ground, a meeting place of the minds. One can't treat people as objects, nor can one forget for a minute that one is dealing with human beings on behalf of fellow human beings. The experience of contributing to a botanic garden to help create and maintain living beauty, seems to me a very special privilege—yet one that is open to all.

What are your thoughts on fund-raising?

If the question refers to botanic gardens, there are times, let's say, when new construction is essential or some new piece of land must be acquired to save it from uncertain fate. In such cases it is necessary to have a drive for capital funds. As for routine support and growth, it seems more likely to come from those who enjoy being involved in creating something beautiful.

If a botanic garden creates the proper

"The . . . very important thing about a garden in my life is that it provides a certain amount of physical exercise. If one can have exercise as well as adding beauty to the landscape, what could be sweeter?"

Roche

image, based on substance, it is my view that voluntary support will be forthcoming, either in capital gifts, in bequests or in more small gifts than needed to help with current operations. It should not be overlooked that if there is an excess of small gifts in any particular year that aren't absolutely needed for operation, they can be added to a reserve for the time when they are needed, meanwhile providing endowment income.

You had the reputation of running a "tight ship" in your 25 years as Director. Do you have any regrets about that?

No. The spending of other people's gift money is a very special trust.

What are your views on a balanced budget?

Most of the eleemosynary institutions with sizeable deficits usually fold up, merge with a more successful institution, or end up on tax support. The BBG has had a remarkable tradition of never operating beyond income. A side effect of such a philosophy, it seems to me, is that one's ideas don't get beyond the limit of what can reasonably be supported. Many institutions add new "programs" on top of old ones, without the wherewithal to support them—an almost certain road to disaster.

I wonder if we could go on to a few horticultural questions. You seem to have been personally more interested in woody plants over the years than in annuals, perennials or greenhouse plants. Is there a reason for this?

Considering all factors, trees and shrubs are longer-term perennials. They generally blossom for two or three weeks a year. For me continuous bloom, such as occurs with most summer-flowering annuals, is not necessarily desirable. It is a refresh-

"I think of plants in terms of where they come from, also as living museum pieces."

ing experience when a shrub blooms, a change of scene. This is always good. Moreover, having a continuous display of one sort or another doesn't necessarily constitute an aesthetic experience. Most of us are thrilled by the dramatic moment of a sunrise or sunset, but if with us all the time they would be commonplace and unnoticed.

Is there a special group of woody plants you are fond of?

If I had to name one, it would be broad-leaved evergreens, although there can be a certain monotony if they are too commonly used. They offer more for the average home gardener than they do for many situations in public gardens and parks.

Most deciduous shrubs lose their character in winter, but trees that lose their leaves in winter offer inherent interest. Each species has its own characteristic "architecture," which can be of considerable interest in the cold months.

What are your personal favorites?

For me, the small flowering trees have great appeal. The common flowering dogwood of the eastern United States is a superb tree, as is the kousa dogwood that came to us from the Far East. Both offer fine autumn color in addition to their charm in the blooming season. Most years the native dogwood is in flower for two weeks and the kousa for as much as a month. The hardy silk tree (*Albizia*) has no autumn color but has a long blooming season. In our mild-temperate climate, some start to bloom in July and continue until early September. Sourwood and franklinia are choice, too. The latter offers little in architectural form but it blooms in late summer and is a relatively unusual tree. In fact, it is not known to have been found in the wild since the early 1800's.

Is it important for you to have a personal garden?

Definitely. By instinct I am a collector and enjoy bringing some of the world's choice plants to my doorstep. I think of plants in terms of where in the world they come from, but also as living museum pieces. It gives me pleasure to know them and grow them. The other very important thing about a garden in my life is that it provides a certain amount of physical exercise. If one can have exercise as well as adding beauty to the landscape, what could be sweeter?

Do you have a current garden project?

Several. Lately I have had an interesting time growing some hybrid Japanese holly. It is called 'Mariesii' or 'Nummularia'. The seeds were collected by a friend who has been growing these hollies for years. Of 100 seeds that he gave me two years ago, not more than a half-dozen have produced plants that are alike. There are dwarfs, semi-dwarfs and others that are gawky in one way or another. We will see if anything develops from these as they grow older. It seems to me that every gardener would enjoy having such an experimental project coming along all the time. It not only offers a continuing interest, but—who knows—a fine variety may come out of it.

How difficult is it to raise herbs indoors?

A HERB GARDEN UNDER LIGHTS

Tilde Merkert

From Plants Alive, April 1975

One of the best things about growing herbs, whether inside or out, is that you can enjoy their fresh, fragrant greenery both visually and gastronomically.

If you can raise them outside in summer, as I do, that's all to the good. But if you have no growing spot, not even a balcony or window box, grow them inside with artificial light. This I do in winter also, using two sets of fluorescent lights in my basement. Incidentally, if one is thinking about the energy crunch, a fluorescent tube uses less juice than a medium light bulb, and gives off three times the light. I conserve in every other way in order to pursue this interest.

Fluorescent light sets needn't be costly. While one of my sets is a canopied, ceiling-suspended unit with two 4-foot fluorescent tubes, the other is a home-constructed, clamp-onto-a-table unit. Here, two tubes are plugged into sockets, wired and supported with metal posts and cross pieces. (One caution: this solution should not be attempted unless one recognizes the do's and don'ts of electrical wiring.) Both sets can be raised and lowered for the seedlings' and plants' needs.

For appearance, a store-purchased unit on wheels may appeal. Or a portable light-with-waterproof-tray model. The latter can be set into a recessed area on a kitchen counter. Or in a living room bookcase. With either, a decorative note is established, and the light energy doubles for seeing as well.

Plants or Seeds?

You can purchase plants already started, at garden stores, or you can sow seed and revel in the miracle of growth from the beginning. Those pre-seeded kits may not be the best for you if you are a beginner, as some difficult-to-start herbs may be included. Buy seeds at garden stores, supermarkets, or through catalogs.

Now, what to grow? If you buy plants, include the harder-to-start sage. Also, those herbs best propagated by professionals from rootings or rootclumps, such as rosemary, tarragon and chives. You might have good results digging a mint clump from a friend's garden and potting it yourself. But allow it "foot" space. Like parsley, its roots are long. Of course, chives can be obtained from many supermarkets.

If you choose to grow from seed, start with easy-to-grow varieties. Usually these are the annuals. A list could include the basils, summer savory (often called the green herb for its affinity in cooking), sweet marjoram (my favorite of all), thyme, coriander (for its tasty seeds), oregano, and that "almost indispensable" parsley, Actually, parsley is a biennial, surviving two years, but also slower to grow and germinate than most of the others. Soaking the seed in warm water for a day speeds germination.

How to Sow

For sowing, have ready some clean 3-inch pots, trays to set them on, and your soil or growing medium. Plastic pots hold moisture better than clay. Peat pots may be used, too. For a starter medium, I like an even mixture in thirds of milled sphagnum moss, clean sand and perlite (or vermiculite). These last allow for root "breathing," and as with the moss, are easily purchased at garden stores. I occasionally sow a larger pan of seed, especially where I want to harvest a lot of tender greenery for cooking, as with dill or chervil.

Sow seed by scattering on top of each pot's soil. Barely cover with more mix. Set the bottom-draining pots in warm water in the sink until the soil surface

Both culinary and aromatic herbs, grown under fluorescent lights or in a well-lighted window, make indoor living more pleasant. Shown here are two favorites: rosemary **(right)** and 'Prince Rupert' geranium **(left),** whose leaves have a strong lemon scent.

darkens. Drain and place under the lights. For a non-draining pan, water carefully from the top. A fine spray or "mister" works well.

Lower the lights to 5 to 10 inches above pots. (I find seeds germinate with light just as well as if I had covered them for a time.) When the herbs show two sets of leaves, thin them out, leaving only 2 or 3 little plants per 3-inch pot. Snipping off rather than pulling protects the remaining ones from being loosened.

When the plants reach 2 inches, transplant them into their permanent pots, maybe 5-inch ones. Here I use a mix of 2 parts commercial potting soil (available at garden stores), 1 part perlite, 1 part milled sphagnum. Sometimes, without commercial soil, I sterilize ordinary sifted garden soil by baking 1 hour at 375 degrees. After the plants have adjusted (a week or so) pinch them back by snipping out the center growth. This encourages branching, and thus more edible greenery.

Care of Plants

Although herbs outdoors thrive with no feeding at all, having inherited a toughness from their Mediterranean origins, indoors they like a mild once-a-month feeding with a soluble plant food. Also, outdoors they tolerate much dryness. So use care in watering.

Yet they do take to humidity in the air, and need help with this. Try setting the pots on wet pebbles in the base trays. Remember that proximity to each other actually manufactures moisture, as with any grouped house plants. Ready-made humidity exists in the kitchen from cooking and dishwashing. Spraying water on the leaves with a mister helps—an absolute "must" for that piney-smelling rosemary. After all, its botanical name is *Rosmarinus*. Translated, it becomes "dew from the sea." I also give plants a bath in sink or laundry tub.

Raise the lights above the plants as necessary. One foot is about right. Foil-covered cardboard set at the sides or underneath bounces light back. Sixteen hours is the usually recommended period of daily exposure, timer controlled. I've tried fourteen with success. Longer than 16 may be detrimental, as plants need darkness and rest just as people do. You might place those herbs that tolerate a bit of shade at the ends where light is diffused—including mint, chervil, oregano and parsley.

Tips and Ideas

A few miscellaneous thoughts here: outdoors, herbs seem absolutely pest-proof;

indoors, whiteflies and aphids may visit. Use no plant spray, remembering your crop is intended for eating, unless it's a mild nicotine sulphate sprayed in the early life. Best to drown the creatures. Hold a cut cardboard or fold-over of foil over pot's soil, dunk and swish plant vigorously.

Again, plants are like people in that they need a little fresh air. But only indirectly. Avoid frigid blasts. For regular temperatures, most herbs prefer a range of 60 to 65 degrees, but will tolerate ranges of 50 to 80 degrees.

Some individual suggestions follow here. Keep the taller herbs (the basils and tarragon) cut back so they fit under the lights. But don't over-harvest any herbs too early. It weakens the plants. Wait until your charges are flourishing well. Then they welcome it.

You may not achieve the stage with coriander where it produces those delectable seeds, so good in desserts and sausage. But then, you just might!

Think of how to use your crop. Snip some rosemary needles to sprinkle on baking chicken. Or chicken wings. And there's sage for poultry and meat dressings. But go easy. It's potent, and even more so when dried. Parsley minced into butter makes potatoes a dish to savor. Chives can garnish your own vichysoisse. Rich thyme-flavored bean and pea soups can augment the family's diet. And remember that you can tenderize cheap cuts of beef with a marinade of oil, vinegar and herbs (try tarragon and marjoram). You can dry some of the crop. And freeze some (but not basil—it turns dark). And how about a bouquet for a friend?

Photographs by George Taloumis

Pineapple sage, while not an important culinary herb, is worth growing indoors because of the powerful, refreshing fragrance of true pineapple emitted by its soft foliage.

Getting more from the

THANKSGIVING AND CHRISTMAS CACTI

J. C. McDaniel

Two different but related house plants are now frequently grown as the Christmas cactus. One is a species from Brazil, the other a hybrid of the first with another Brazilian species, now hardly ever cultivated in the United States.

The species that is most commonly propagated by nurseries is correctly called *Schlumbergera truncata.* Although it was originally named *Epiphyllum truncatum* by Haworth in 1819, it does not belong in the *Epiphyllum* genus, but in *Schlumbergera* according to an English botanist, D. R. Hunt, who published the latest synopsis of that genus in the *Kew Bulletin* (23: 255-263, 1969). Other synonyms are *E. bridgesii* and *Zygocactus truncatus.* This plant has stems whose segments bear well-developed "claws," and the flowers, which can appear as early as November, are unsymmetrical. It is sometimes called crab-claw cactus, also Thanksgiving cactus. Many color forms from nearly white to purple-flowered are now known.

Schlumbergera x *buckleyi* is the approved name for the old hybrid which has been in general cultivation as Christmas cactus for well over a century. Its Latin name commemorates W. Buckley, an English gardener who originated this hybrid before 1852 by crossing the rare (and rarely flowered) *S. russelliana* with *S. truncata.* The hybrid is also frequently listed erroneously as *S. bridgesii.* It can bloom before Christmas but usually more prolifically a little later, and is noted for its more regular-shaped flowers of Tyrian rose color, and stem segments only obliquely crenate-margined, not clawed. In these two respects it more nearly resembles the still rarely seen *S. russelliana* parent, a native of higher altitude in the same mountains where *S. truncata* grows wild.

There are various color forms of *S. truncata* that are available from some specialists in cacti. Most of *S.* x *buckleyi* in this country is apparently one of Buckley's old magenta-flowered clones. However, several newer ones in various colors have been obtained by breeders from crossing back to *S. truncata* clones, for many years in Germany, but also recently here.

Getting Flowers

Growing either of the common *Schlumbergera* as just a foliage plant is not too difficult. They are somewhat resistant to drought but are definitely not desert plants like many other cacti, so should be watered more frequently and given summer shade. It is interesting to note that in the Organ Mountains of Brazil *Schlumbergera* grows on tree trunks and on rocks covered with other plants.

For flower-bud initiation and retention, day length, and—to a lesser extent—temperature are critical. *Schlumbergera* are short-day plants. If days are artificially extended by electric illumination much beyond the normal length between October and March, not many flower buds will start or grow to maturity on these cacti. Apparently even just one evening under bright lights can cause most developing buds to drop without opening. Therefore, it is best to set them near a window of a room with no continuous or even frequent evening lighting. If such a site cannot be provided, cover the plants each evening with a dark cloth and remove it the next morning. Cool temperatures, 65° F. or down to 50° at night, are also recognized as stimulants to flower-bud production. Ethylene gas, which may be given off by ripe bananas, apples and other fruits, is said by some to cause flower buds to fail, so it may be wise to not have the fruit bowl near the cacti.

(Continued on page 18)

Photographs by George Taloumis

Above: In or out of flower, the Christmas cactus makes an attractive house plant. **Right:** Even young specimens of the Christmas cactus may be expected to bloom.

Fruits and Seedlings

Colorful fruits can add to the year-round decorative value of *Schlumbergera,* but they are seldom seen on home-grown plants. The reason is that individual plants and clones are incompatible to their own pollen. But if two clones, either *S. truncata* or *S.* x *buckleyi,* are grown and are in bloom at the same time, they will usually develop fruits following cross pollination by hand. Exceptions may be some of the recent female-sterile commercial cultivars. In fact, one breeder is aiming to market only non-fruiting cultivars to prevent competitors from getting new, possibly better clones.

Flowers should be cross pollinated the day they first open fully. Fruits from successful crosses enlarge to nearly mature size in a few weeks, but do not get their ripe color until mid-summer or early autumn. Then they will hang on for another year or longer. The angular fruits of *S* x *buckleyi* are usually paler than the smoother ones on *S. truncata.* Each fruit can contain up to 50 or more seeds.

Fresh seeds germinate quickly if taken from ripe fruits and sown on a moist surface. My first seed lots were sown in a greenhouse mist bed in early October. Germination occurred within three weeks, but the seedlings grew very slowly under normal daylight until March, when longer days seemed to cause more rapid development. Perhaps spring sowing would give equally good results and also avoid the tedium of carrying very tiny plants through the first winter.

Grafting

Seedlings on their own roots may take two years or longer to first flowering. Grafting them on an established stem of another cactus can reduce the time of waiting to evaluate the results of cross breeding.

Schlumbergera can be grown higher above a pot when it is grafted on stocks of many other cacti. The favorite stock is *Pereskia,* a primitive leaf-bearing, vigorous shrubby genus from the American tropics, but almost any erect-growing cactus can be used, even the prickly-pear species (*Opuntia*). *Pereskia* propagates readily from cuttings and is recommended. Start with a rooted *Pereskia* stem, decapitate it, and use a sharp knife or razor blade to side-graft the *Schlumbergera* cuttings or seedlings near the top of the cutback *Pereskia.* A spine from *Pereskia* may be used to pin a scion in place. After grafts are established, prune off any competing growth from the *Pereskia.*

Getting Tree Roots Out Of Sewer Lines

From American Horticultural Society News & Views, July 1975

SINCE 1937, the town of Ridgewood, New Jersey, has been applying an old time remedy for ridding sewer lines of tree roots. The town distributes quarter-inch crystals of copper sulphate which they turn over to house owners in quart-size cardboard containers holding slightly less than 2 pounds of material. Instructions call for the crystals to be poured into porcelain toilet bowls which are connected by a lead bend to the soil pipe (never into sink which has a thin-walled trap). Flushing and agitating with a plunger makes sure that all crystals are carried down the drain and assures no damage or stain to the porcelain. Twice-a-year treatments give excellent control of roots in tile sewer connections and there is no evident injury to trees or plants whose roots are killed. Back in 1961, the township discontinued the program for one year and found the cost of maintaining sewer lines rose 40 percent. They haven't discontinued the program since.

A survey of

THE THORNLESS HONEY LOCUST

One of the most widely planted trees in recent years has been the thornless honey locust (*Gleditsia triacanthos inermis*) in its various cultivars. It is derived from a species that is commonly found in the flood plains of the lower Ohio Valley, although the native range extends from Pennsylvania to Kansas, Texas and Alabama. The species itself, a member of the Bean Family (Leguminosae), is fiercely thorny and has large carob-like seed pods that little boys like to break open and chew on because of their sweetness. Grown-ups and nurserymen, in particular, don't like the thorns or the pods so have selected unarmed and sometimes fruitless clones, which are sold in great numbers each year.

The reasons for the popularity of the thornless honey locust are many. The fresh green, compound leaves, composed of leaflets that are arranged like tiny ladders reaching out to the sky, have a refined, airy texture, even in urban grime. The tree outline or "architecture" is graceful in both summer and winter, especially when a starkly modern office building is in the background. In winter the smooth, steel-gray bark adds an impression of cold strength, even if the tree is seen in the promenade of a Manhattan skyscraper, as is often the case these days. Although the thornless honey locust has been around for more than a hundred years, it is a tree of the 1970's.

Large specimens are known, but the thornless honey locust is not considered out of scale in most home or street plantings—at this time. It's a shade tree to be sure, but the light canopy of foliage permits grass and other plants to grow well underneath. Autumn color, though not spectacular, is modestly pleasing, particularly in country or suburban areas where the foliage often turns a bright gold before falling. Reluctant leafrakers

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are fond of the tree because the tiny leaflets just seem to disappear in the lawn, requiring no October clean-up.

A principal reason for the widespread cultivation of the thornless honey locust in municipalities has been the demise of the American elm. It doesn't resemble the elm at all, but people in charge of street-tree plantings, and perhaps people generally, are still fond of long avenues of a single kind of tree. The visual unity such plantings provide can be striking, but it poses the danger of monoculture, for once an insect pest or disease crops up it can race through the streets like wildfire —as happened to the elm on the main thoroughfares of thousands of small towns around the country.

To learn more about the performance and employment of the thornless honey locust, a PLANT & GARDENS questionnaire was sent to 17 leading horticulturists in different parts of the United States. The results were revealing because most of our correspondents caution against excessive use of this tree (or any tree), although regarding it as a fair-to-good ornamental in cooler areas (central New Jersey northwards) where the mimosa webworm is not present.

Based on the survey, the thornless honey locust is not a prime tree for the South, nor does it appear to thrive in very dry or very cold climates. Also, strong winds are an inhibiting factor in some areas. Within these limits, though, the tree is rather adaptable as to soil requirements, and it seems to hold up under urban conditions better than most.

Actually, there is no single thornless honey locust, for cultivars are numerous. There is little apparent horticultural difference between some, and our reporters feel there may be too many cultivars, although two of them think that if careful further selections were made for special ornamental or pest-resistant traits, they could be worthy additions.

The oldest of the currently popular cultivars, 'Moraine', patented in 1949, is somewhat resistant to mimosa webworm (Santamour, National Arboretum), which is present in 26 states, but it has been criticized by some for its spreading growth habit. 'Shademaster' and 'Skyline' are other widely planted cultivars with a more erect habit.

Two foliage novelties are 'Sunburst' (new leaves yellowish throughout most of the season, giving a flowering effect when seen from the distance) and 'Rubylace' (dull reddish green). Special attention to the landscape site is important for the first cultivar because it is very distinct from other trees and can strongly dominate the scene. Also, in parts of the country (California) where iron deficiency is common, it gives the appearance of being just another chlorotic tree. Neither cultivar is noted for an excellent growth habit, and at the Brooklyn Botanic Garden an undue amount of spider mite damage has been observed on 'Rubylace'.

Attention should be called to the work of Frank S. Santamour, Jr. and colleagues at the National Arboretum. One of the current projects there is a study of mimosa-webworm resistance among all twelve-or-so species of *Gleditsia*, not simply *G. triacanthos*, which is the principal one in American cultivation. In addition a biochemical survey of the genus is being done. They have also obtained the first controlled hybrids in *Gleditsia*. Mass screening of webworm resistance is underway.

Replacement for the American Elm

Our reporters were asked for their thoughts on a replacement for the elm. Most felt that there should indeed be no single tree because "monoculture," as occurred with the elm, hastened the spread of the Dutch elm disease. Apart from this consideration, Richard Walter asked, "Is there such a tree? Every time I see a mature American elm I marvel at this perfect masterpiece of nature. I cannot think of any other tree that might even touch its majesty." Clancy Lewis and Frank Santamour simply added, "Let's stop talking about it."

Paul Mitchell responded: "I suggest that every community have a list of recommended street trees. They should be

(*Continued on page* 25)

Cole Nursery Co.

'Skyline' honey locust is considered desirable because of its erect-growing habit.

Comments by Contributors to Survey on Value of Thornless Honey Locust

Contributor and State	*Rating for General Use on 1-10 Basis (6 Being "Passing")*	*Strong Points*	*Weak Points*	*Best Cultivars*	*Other Trees Preferred*
Horder (Alabama)	7	Not often used in Mobile, though native farther north in the state; needs further testing	Webworm may be a limiting factor; cvs. from northern periphery of spp. often unsatisfactory here	—	*Ginkgo, Quercus phellos, Q. shumardii, Pyrus calleryana* 'Bradford', *Chionanthus retusus, Sapium sebiferum*
Engard (Arizona)	5	Glossy foliage and deciduous habit, allowing winter sun to penetrate to houses and patios	Some cultivars have a litter of pods; heat stress in summer here — requires extra watering; at 3,500-6,000 ft. we have seen it grow nicely at abandoned homesites	—	Native desert trees or ones from other desert regions of the world
Chandler (California, Southern)	7	Splendid structure especially when bare; good foliage; no predators or diseases here; more testing needed	Late to leaf out, as occurs with several cold-climate plants in mild areas; I feel that native or introduced plants suggesting the flavor of the region are preferable to "universals"	'Moraine'; others need testing; 'Sunburst' to be avoided because of chlorotic appearance	*Eucalyptus* spp., *Platanus* x *hispanica* (*acerifolia*), *Cupaniopsis anacardioides, Podocarpus gracilior*
Hildreth (California)	5-6	Rapid growth; filtered shade; insect and disease resistance (aphids and tent caterpillars are minor problem); tolerates some heat and drought, and adapts to most soil situations	Excessive root growth in restricted areas; wind damage; modest autumn color; occasionally even "fruitless" forms have fruit and "thornless" ones have thorns; there are better trees for California	'Moraine' (if true), 'Sunburst', 'Imperial', 'Shademaster'	Many; street tree list available for central and northern California
Feucht (Colorado)	7	Fairly rapid growth; late to leaf out, hence avoiding spring frosts; no leaf-raking; light shade	Sunscald; periodic winter injury; Thryonectria canker (fatal) in older plantings; spider mites	'Skyline', 'Shademaster'	Yes

Contributor and State	Rating for General Use on 1-10 Basis (6 Being "Passing")	Strong Points	Weak Points	Best Cultivars	Other Trees Preferred
Galle (Georgia)	5-6	Quick growth; provides light shade	Wind damage; 20-year old trees dying here, perhaps from mild winters and early spring freezes; mimosa webworm	——	*Acer rubrum*, *A. floridanum*, *Quercus palustris*, *Q. phellos*, *Q. acutissima*
Eickhorst (Illinois)	6-7	Fine texture and light shade; ease of transplanting; fairly rapid growth	Wind damage; insect and canker problems. A flood-plain species, it is too often planted in uplands; grossly overused	'Skyline', 'Imperial', 'Green Glory'	Cvs. of *Acer saccharum*, *A. platanoides*, *A. rubrum*, *Fagus sylvatica*; *Quercus palustris*, *Tilia cordata* 'Greenspire', *Pyrus calleryana* 'Bradford'
Wyman (Massachusetts)	6	Excellent in cities	Inconspicuous flowers and fruits (some thornless cvs.); modest autumn color		Ones with attractive flowers. fruits and good autumn color
Lewis (Michigan)	6-7	Light shade lets turf grow; good near buildings with much glass—allows light through; no sidewalk problem in downtown areas; excellent texture	More and more susceptible to pests; questionable weak crotches; brittle branches possible	'Shademaster' (wind resistant), 'Majestic', 'Skyline', 'Sunburst'	Yes, depending on site and purpose
Snyder (Minnesota)	5	Gives light shade	Not completely hardy here; wind-exposed trees require training	'Sunburst', 'Skyline', 'Shademaster'	Yes
Flemer (New Jersey)	10 (N. of N.C.Y.) 6 (N. of Baltimore) 5 (S. of Baltimore)	Soil and urban adaptability; ease in transplanting; rapid growth	Mimosa webworm in South	'Shademaster', 'Skyline', 'Continental'	*Acer saccharum*, 'Green Mountain', *A. rubrum* 'October Glory', *Tilia cordata* 'Greenspire'
Walter (New Jersey)	6	Casts light shade; minimum leaf litter; fairly deep root system; other plants thrive nearby; good recovery from transplanting	Not very ornamental; growth habit unpredictable, even in clones; insect and storm damage	'Majestic', 'Shademaster', 'Sunburst'	Many

Comments by Contributors to Survey on Value of Thornless Honey Locust (Cont.)

Comments by Contributors to Survey on Value of Thornless Honey Locust (Cont.)

Contributor and State	*Rating for General Use on 1-10 Basis (6 Being "Passing")*	*Strong Points*	*Weak Points*	*Best Cultivars*	*Other Trees Preferred*
Pirone (New York)	7	Hardy; relatively free of pests (midge pod gall is present here); fairly tolerant to air pollutants	Some cvs. such as 'Moraine' have pendulous branches resembling grapevines	'Shademaster', 'Skyline', 'Rubylace'	*Tilia cordata, Platanus* x *hispanica (acerifolia), Zelkova serrata*
Collins (Ohio)	9	Adaptable to soil type; no leaf litter; good for lawns because of light shade; easy to transplant but slower to leaf out than most; nursery produced trees are structurally strong; topnotch here	Dodgan and green plant bug may cause damage; gall infections reported more severe when planted north and west of original native range; in South webworm	—	Depends on site
Mitchell (Oklahoma)	5	Drought resistance; deep roots; small leaflets permit good turf beneath; rapid growth	Mimosa webworm (severe) and borers; sunscald of trunk; erratic branching trees need training for proper crown development; why plant a problem?	None recommended, though 'Imperial' and 'Moraine' grow well in most of state	*Fraxinus* 'Marshall's Seedless', *Ginkgo* 'Autumn Gold', *Pyrus* 'Bradford', *Ulmus parvifolia, Sapindus drummondii,* many others; list available
Mulligan (Washington)	6	Small foliage easily dispersed in autumn; hardiness and adapatability to varying soils and climates	Often has weak crotches; named cvs. essential for uniformity	'Moraine'	*Prunus, Malus, Magnolia* and *Cornus* for flowers and fruits; *Liquidambar, Fraxinus ornus, Prunus* x *blireiana, Acer rubrum* and *Carpinus betulus* 'Columnaris' for streets
Santamour (Washington, D. C.)	8 (if no webworm present)	Unique character; no leaf litter; urban tolerance; soil adaptability	Mimosa webworm here; I don't advocate planting trees that must be sprayed	'Moraine' (somewhat resistant to webworm), 'Shademaster', 'Skyline'	Different sites require different trees; oaks, planes, maples, Callery pear have one or more advantages in different areas

evaluated carefully for this purpose and no known tree with a climatic or pest-susceptibility problem should be planted. Further, it may be difficult, but some sort of control should be exercised over the number of trees of single species that are planted. Aesthetically, I believe in species unity along the street; however, I would urge that regions be limited to certain street species, changing species as often as possible. If a single species is planted along a street, an entirely different species might be planted in the back of residential homes. Similarly, in parks there should be a high degree of variety among trees."

To substitute for the elm, our reporters suggested a mixture of trees. Despite the great geographical diversity of the country, several kinds were mentioned frequently—cultivars of red maple (*Acer rubrum*), little-leaf linden (*Tilia cordata*), pin oak (*Quercus palustris*) and green ash (*Fraxinus pennsylvanica*). Most often cited of all were the Japanese zelkova (*Zelkova serrata*), particularly the cultivar 'Village Green', and hackberry (*Celtis* spp.).

The latter has been overlooked by home gardeners in many areas, although there are countless fine specimens of *C. laevigata* in the Deep South, and in the West *C. sinensis* and *C. australis* have gained a certain prominence. Concerning *C. australis,* which is the European hackberry, Philip Chandler of California remarked, "I recently looked at specimens in Lisbon streets, trees nearly 200 years old, and could find no sign of predators, disease or pavement disturbance. This should be a promising tree for street and park department in many areas because it doesn't break sidewalks."

George Taloumis

'Moraine' honey locust, the oldest cultivar, is criticized for its spreading growth.

The meaning of "full sun" varies tremendously in candle power from Alabama to Utah, to New Jersey to Oregon — to Vermont

WHAT DO YOU MEAN BY "FULL SUN?"

Lewis Hill

From Organic Gardening, March 1975

Latitude, the sun's angle, elevation above sea level, and the amount of clouds or fog all affect much light a plant gets per growing season. Local plants have sometimes adapted to their growing climate, but the ones brought in from other areas often require special care when you choose their location.

Even then, one should be aware that light conditions may change. About 15 years ago we planted a 'Blue Ramona' clematis vine by a front porch of our Vermont home. It bloomed for several years in mid-July; then each year it began to bloom a bit later, until it now blooms in mid-September. Same plant, same location.

In our vegetable garden we have to be sure that tall-growing plants like corn, sunflowers, peas and Jerusalem-artichokes are planted so they will not shade the heat-loving plants like tomatoes, peppers, eggplant and melons later in the summer. Pumpkins and squash are traditionally planted among corn hills, but we find they also need full summer sun on our northern mountain.

Of all the berry plants, only the elderberry does well even if it doesn't have full sunlight. It does well in light shade, although the berries ripen so much later there is risk of losing them from early frosts.

Although a clematis plant is supposed to need only a little morning sun (a northern exposure is often suggested, in fact) we have found a few hours of early sunlight is not enough for it in northern Vermont. A growing maple in our front yard has cut off the sunshine a few minutes earlier each year. The vine is now shaded by 11 o'clock. Apparently it needs sun until noon to bloom in mid-July.

A growing shade tree was to blame, too, for a decline in bloom of one of our favorite lilac bushes. We noticed that it bloomed less and less each year and couldn't understand the reason; finally it became clear that it was in the shade of a neighboring maple.

Lilacs need almost 100 percent full sun to blossom well here. They can grow beautiful foliage with less sun, but they don't bloom. Most annuals, roses, dahlias, gladiolus, cannas, many perennials and most flowering shrubs also need full sun. Even evergreens get scraggly without it.

Usually "full sun" means from sunrise to three o'clock in the afternoon. Morning sun is most important in cool climates because it warms quickly, and the heat will hold through the day and into the evening. Plants that only get the late afternoon sun miss so much of the day's warmth and light that they never do get quite enough.

In the north, June and early July days are very long; but after that, days shorten quickly. To make a full season's growth, most plants need all the sun they can get.

For example, hardy ground covers such as periwinkle (*Vinca minor*) or bugle (*Ajuga*) grow beautifully here in full sun as well as shade, even though they are usually thought of as being only for shady spots. Begonias, too, are always recommended for northern shady spots; but we find that both the tuberous giant flowering kinds and the fibrous small blooming ones need a few hours of early morning sun to grow well and blossom their best.

George Taloumis
Elms cast their spreading shade on a lawn in Bennington, Vermont. In the north, morning sun is best for plants because its heat holds through the day and into evening.

Finding foundation plants that will grow on the northern or eastern sides of buildings is a landscape problem in the northern mountains. Shade provided by buildings, fences and walls allows more reflected light than that provided by trees, however. Trees let in very little skylight, thereby giving too much shade. Also, their roots compete with the plants for nutrients and water—an important consideration when planning landscape shrubbery.

Most all of our annuals, perennials, vegetables, berries and ornamentals we grow in pretty much full sun. We're great believers in mulches of organic materials —especially maple leaves—which help give a cool, woodsy home for plant roots and insure against drying out when droughts do occur.

Though we have found most plants need more sun in the north than in warmer parts of the country, there are still many plants that thrive in cool shady spots, even under large trees. Most ferns, Canadian yew, many wildflowers, medicinal herbs, hosta, day-lilies, myrtle, and even shrubs like the Peegee hydrangea and several perennials grow in light to moderate shade.

For most cultivated plants, however, more—not less—sun seems to be necessary for us northern gardeners. Mulches, extra water, even artificial shade can provide relief in the infrequent hot, dry spells. If long-range weather predictions are correct, we must expect fewer, not more, warm, sunny days in the future.

When leaves drop . . .

CULTURAL SHOCK IN FOLIAGE PLANTS

ARE your new foliage house plants not thriving? There may a good reason, according to Charles A. Conover of the Agricultural Research Center, Apopka, Florida. Sometimes they are not properly acclimatized in the huge outdoor nurseries in the milder parts of the country where they are raised. *Ficus benjamina, F. retusa nitida* and, to a lesser extent, *Brassaia (Schefflera) actinophylla,* grown in full sunlight, will frequently drop their upper sunexposed leaves when transferred to the lower light intensity of the average house, while the lower, shaded ones persist.

The shade-grown leaves are better indoors because they are thinner and larger, the chloroplasts are dispersed within cells and the grana have a horizontal orientation. According to Dr. Conover, these mechanisms enable shade-grown leaves to absorb more of the incoming light energy, which allows them to photosynthesize more efficiently in the house.

Another reason for some foliage house plant difficulties is excessive fertilizing during the latter stage of growth in nurseries. This has been especially noted with palm, dracena and schefflera when brought indoors. In the low-light intensity of apartments and office buildings, they require fewer nutrients for best performance.

Symptoms of overfertilization "shock" are burned foliage, leaf drop and general loss of color. Dr. Conover's remarks were made at the 1975 meeting of the American Association of Nurserymen.

George Taloumis

Schefflera is an example of a popular foliage plant that needs special treatment from its southern nurseries before being shipped north to city sale outlets.

HOUSE PLANT PAPERBACKS

Lemuel Hegwood

GROWING house plants is like brushing one's teeth: most everyone agrees about the general rules of dental hygiene but when it comes to details, everyone has his favorite way of squeezing the tube of toothpaste. So it is with house plant books, too.

The books mentioned here were among twenty purchased at random from several stores and are a fair sampling of what's on the market today. All are paperbacks and show remarkable variety. The first group is about house plants in general, and each book costs less than a good trowel.

The World Book of House Plants Elvin McDonald. World Publishing Co., New York. 1963.

This comprehensive treatment is clearly illustrated and written by a well-known garden writer. An extensive number of plants are covered in some detail. They are referred to by botanical and common names and are listed by family. The information on particular plants is ideal for an experienced grower, but the beginner, due to the large scope of plants and general absence of plant-use lists may be overwhelmed. Culture is covered in depth, and the excellent section on diagnosis of house plant trouble is alone worth the book's price. There are chapters on terrariums, bulb-forcing, indoor herbs, plant standards and baskets, too. This book is hard to beat.

The Apartment Gardener Florence and Stanley Dworkin. Signet Classics, New York. 1974.

The Dworkins' individualistic approach to apartment plants has all the essential "bones." Their style is refreshing and the information spiced with anecdotes. The advice on culture and plant material is clear, comprehensive and practical. The information is mostly from the authors' experiences: its depth and broad treatment outweigh an occasional near-sighted approach in some areas, as on soils and pesticides. A fairly small number of species are covered in detail, but important botanical families such as the orchids are dealt with at length. There are sections on herbs and terrariums as well as kitchen-scrap and indoor vegetable gardens. The inclusion of commercial sources, information services, references and plant societies helps make this a thorough compendium. It also has an index.

How to Grow Beautiful House Plants T. H. Everett. Faucett Publications, Inc., Greenwich, Conn. 1973.

Unlike the other books presented here, this down-to-earth guide was written by a professional grower, the former horticulturist at the New York Botanical Garden. Cultural procedures followed by many public and private greenhouse growers are clearly described, as are the special techniques of bulb-forcing and hydroponics. Chapters on the peculiarities of traditional house plants fill the latter half of the book. Unfortunately, many plants newly introduced to American homes are not included in this revision of an earlier work. Home gardeners with elbow room and cool cellars will find the book useful.

Greenworks Judith Handelsman and Sara Baerwald. Collier Books, New York. 1974.

Written for those who prefer to read about swimming before they get their feet wet, this book is well illustrated and has no professional jargon. It covers a small number of reliable plants and contains general growing information. There are brief sections on kitchen-scrap gardens and terrariums, as well as a detailed index. Unfortunately, the route of generalization has been mistaken for a simple approach and limits the usefulness of this book. However, it's a fine gift for the novice. *(Continued)*

Of Special Interest

Rising interest in indoor gardening has opened the field to special titles. Here are a couple:

House Plants to Grow if You have No Sun Elvin McDonald. World Publishing Co., New York. 1975.

After reading most general house plant books, the sunless gardener is left more aware of what he can't do than what he can. Because of the problem of poor light, the would-be grower is apt to throw his hands up in disgust and buy a fish tank. This book is a beacon in a dark world. It discusses a large number of plants for low-light situations, also ways to increase the available light. This does not replace a general house plant book, for basic cultural procedures are scant and there is no index. The detailed listings of growth requirements for each plant are for people with some growing experience. Pronunciation of botanical names and lists of periodicals and plant sources are included.

The After-Dinner Gardening Book Richard Langer. Collier Books, New York. 1969.

It was refreshing after reading several serious house plant volumes to come across this entreating paperback. The book is filled with whim as well as horticultural insight that sheds new light on some old dinner-table favorites. The basics of growing plants from avocados to yams are here and, though the specific how-to information may require some searching, Mr. Langer makes the trip worthwhile. Gardening with leftovers has reached a new height with this delightful book.

The Price Goes Up

Paperbacks come in large and small formats and it appears this is what largely accounts for the range in price of house plant books. Small books are at times big on information. The same can be true for big books. The following books have a large format and are a little more expensive than a good trowel.

Rating and Raising Indoor Plants Virginia Beatty and Editors of Consumer Guide. Publications International, Ltd., Skokie, Ill. 1975.

Growers looking for plants for a specific purpose will find this book's unusual approach handy. There are lists of plants by size and growth habit, best temperatures, foliage color, flowering periods and ease of culture. Also, systematic information on the size and temperature, ventilation and soil are given for plants grouped according to similar light and water requirements. This scorecard approach, so long used for hardy plants, is a goldmine. Over 200 plants are covered in detail. However, cultural information is loosely organized and incompletely indexed. Brief accounts of "garbage," windowsill, kitchen, hanging and bottle gardens, terrariums, bonsai, saikei and bulb-forcing are included. There are also plant society addresses, sources of information and a list of mail-order firms. This is a worthwhile addition to the library.

Apartment Greenery Jean F. Blashfield. Little, Brown and Co., Boston. 1975.

This garden-variety house plant book has good general advice and excellent line drawings. Plants doing well in apartments with a minimum of attention and providing year-long interest are treated in detail and are well indexed. The cultural information is general, but some techniques are overexplained. There are sections on terrariums, window gardens, hydroponics and a systematic house plant chart is provided.

House Plants for Every Window Dorothy Jenkins and Helen Van Pelt Wilson. William Morrow and Co., Inc., New York. 1975.

Originally published in 1944, this book contains clear, useful information on growing techniques and old-fashioned, but not obsolete plant material. Few 'modern' indoor plants, including the diminutives favored today, are included. Particularly provocative is the way house plants are treated as components of the interior decor. This design approach to house plants, just now becoming popular, has been generally neglected in favor of plant collections. Unfortunately, the styles described here are not ones favored by contemporary tastes.

Additional Books

The House Plant Answer Book Elvin McDonald. World Publishing Co., New York. 1975.

House Plants for Five Exposures George Taloumis. Signet, New York. 1973.

Care and Maintenance of Common Household and Office Plants Mary L. Anderson and Franziska Hecht. U. S. Government Printing Office, Washington. 1973.

101 Flowering House Plants Anyone Can Grow T. H. Everett. Faucett Publications, Inc., Greenwich, Conn. 1975.

The Indoor Water Gardener's How-to-Handbook Peter Loewer. Popular Library, New York. 1973.

George Taloumis

A tree for indoors is the weeping fig (*Ficus benjamina*), shown here with Boston ferns.

Philip B. Mullan

The Cranford Rose Garden at Brooklyn is the third largest rose garden in the U.S.A.

WE ALWAYS PROMISE YOU A ROSE GARDEN

Ann Reilly, with Peter Malins

FOR the past 48 years a very special summer attraction at the Brooklyn Botanic Garden has been the Cranford Memorial Rose Garden, where 5,000 plants of 900 different species and hybrids prosper under the care of Peter Malins. In terms of varieties grown, it is the third largest rose garden in the United States. Because of the initial generosity of Mr. Walter V. Cranford, the continuing gifts of the Cranford family and friends and the warm assistance of many of America's leading rose growers, including Jackson & Perkins, Conard-Pyle Co., Armstrong, Ty-Tex, Kern (old roses), Tillotson (old roses), Inter-State and Wyant, it is certainly one of the most attractive and best kept gardens of is kind in the country.

Mr. Malins has served as Rosarian for 16 of his 27 years at the Botanic Garden. In that time he has amassed a wealth of practical information on growing roses. He is always willing to share his knowledge and experience with Botanic Garden members. but at the start of a new gardening year the moment seems particularly appropriate to summarize a few of the down-to-earth practices that have contributed to the success of the Cranford Rose Garden.

Soil Preparation

The first step, naturally, in the creation of a rose garden is the good earth itself. Often it's not all that good to begin with. Since roses are woody perennials and even the relatively short-lived hybrid teas can go on for many years (15 is the average at BBG, but 20 or 25 are not uncommon), it pays to prepare the soil well in the beginning. Good drainage is a requirement for the vast majority of garden plants, but for roses in particular. Some-

BBG's rosarian Peter Malins begins to prune rose bushes in mid-March after heavy frost possibilities are remote. Three or four canes, about 18 to 24 inches tall, are left on each bush.
Arthur Norman Orans

times, this is best accomplished by elevating the beds from 8 to 15 inches if the site is low and poor drainage a chronic problem. The site should be sunny.

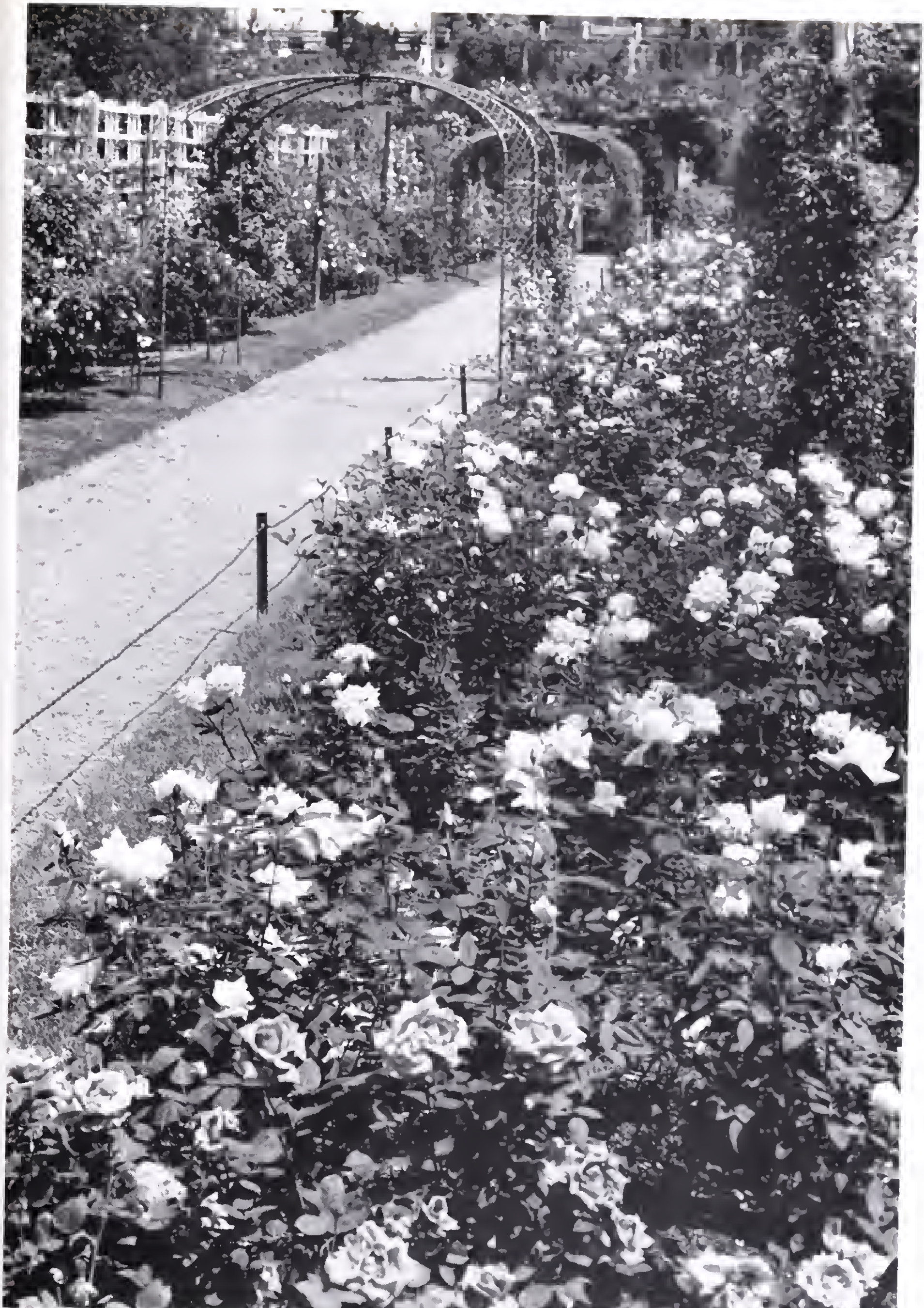
Soils vary, and so do digging requirements. In the new Hunnewell Rose Garden at the Clark Memorial Garden, BBG's outreach station in Albertson, New York, the basic soil was quite sandy—as it often is on Long Island. The top 18 inches of soil were thoroughly worked, peat moss and compost being incorporated to improve the water-retention capacity. In general, unless the soil is poor and there is a layer of hardpan, this is deep enough. In heavy soils, a thorough mixing in of coarse builder's sand may be necessary to increase drainage.

If there is good garden soil already on the site, an addition of 25 percent compost, thoroughly incorporated, will improve soil structure considerably. If compost is unavailable, use peat moss or other organic matter that is well decomposed. In addition, 4 pounds of balanced commercial fertilizer (8-8-8 or similar) will promote initial growth. Digging of a rose bed should occur at least three weeks before planting when dolomitic limestone should be added if needed.

Planting

This is the second step, and the old adage about not putting a five-dollar plant in a fifty-cent hole still holds true. Dormant, bare-root roses are to be preferred over container plants, although the latter permit the home gardener to extend the planting season into summer, providing pot-bound roots are pruned to prevent girdling.

Bare-root roses can be planted in spring or autumn in the New York City area, but the early spring, which will allow time for the roots to become established before summer heat sets in, is recommended. Always soak roots of rose bushes in water before planting; six hours is usually sufficient. Another method is to soak the roses in mud prior to planting, for mud adheres to the roots better than plain water, with less drying out resulting dur-



Gottscho-Schleisner

The Cranford Rose Garden at peak bloom time in June. It contains 5,000 plants of 900 different species and hybrids. A favorite rose is 'Tropicana', with large, orange blooms.

ing the actual planting.

As far as spacing is concerned, 18 inches apart is a good distance for floribundas, and 18 to 24 inches for hybrid teas and grandifloras. Climbers should be set out with 8 to 10 feet between plants.

Post-Planting Care

Pruning is done in Brooklyn in spring after heavy frost is past, beginning in mid-March and continuing through April. After dead, sick, weak or diseased wood is cut out, three or four canes are left and cut back to 18 to 24 inches. Cuts are always made just above an outside bud and at a 45° angle; any sharper a cut than this will result in the drying out and subsequent death of the top bud.

The rose, being a prolific and long-flowering plant, requires regular and frequent fertilization. At BBG, fertilizing is done three times a year—immediately after pruning in April, after the first flush of heavy bloom in June, and at the end of August. The timing of this last feeding may vary across the country, depending upon the local climate, from August 15th in the colder areas to September 15th in the warmer sections. A balanced commercial fertilizer such as 7-7-7 or 8-8-8 is used.

Mr. Malins recommends a soil test, including a pH test every two years, or in any new garden bed. He explains that roses grow best with a soil pH of 6.2 to 6.8, which will require liming approximately every two years in the East. Lime, in addition to raising the pH, will improve the porosity of the soil, although it may take several applications over several years to achieve the required effect.

Most rose insect problems can be solved with Isotox insect spray or 57 percent malathion insect spray. An alternative organic spray is Black Leaf 40. For red spider mite, kelthane is used; for the occasional midge, a diazinon soil drench. Blackspot is kept under control with Phaltan and mildew with Benlate (benomyl). A spray, in contrast to dusting, is given every ten to fourteen days in the Cranford garden from mid-May to October.

Summer's heat brings the need for watering, but there is no need to become a slave to the garden hose. We water well once per week and don't allow the foliage to become wet, although this is acceptable if done early in the morning or in gardens with excellent air circulation. To keep the ground attractive and tailored, cool, moist, and free of weeds, a mulch is applied, 3 inches thick, in May after fertilizing and pruning are finished. Buckwheat hulls are the principal mulch used in the BBG Rose Garden because they don't cake. Cocoa bean hulls have a very fine texture and are best mixed with 50 percent sawdust. Sugar cane is very acid—if used, lime must be added annually; peat moss is not a very satisfactory mulch, except the German, which is very coarse.

Winter protection in the past consisted of hilling up roses with soil and aged cow manure, but now this practice is no longer followed at BBG. The mulch applied to the ground in spring is allowed to remain, for it keeps the ground at an even temperature and prevents loss from freezing and thawing. Gardeners in areas with very cold winters can choose from the traditional hilling-up method, using rose cones or mulching with salt hay.

Favorite Roses

There are many favorite roses in the Cranford garden. Mr. Malins, if pressed for just one, would probably name 'Tropicana' because of its large orange blossoms, ease of culture and pest resistance. However, the list of other outstanding varieties of hybrid teas and grandifloras is a long one indeed. 'Fragrant Cloud' and 'Command Performance' are recommended among the oranges; 'Queen Elizabeth', 'First Prize' and 'Duet' are but a few of the good pinks (there are more pink roses than any color); 'Pascali', 'White Masterpiece' and 'Garden Party' rank at the top of the whites; 'Summer Sunshine', 'King's Ransom' and 'Peace' are favorite yellows; highly regarded reds are 'Mister Lincoln' and 'Oklahoma'; among the bicolors suggested are 'Kordes Perfecta', 'Granada', 'Rose Gaujard' and 'Arizona'. Leading floribundas are 'Europeana' (red), 'Spartan' (orange) and 'Iceberg' (white). For a climber, 'Don Juan' (red) or 'Golden Showers' (yellow) is tops.

Many gardeners lament over the lack of fragrance in many of the modern roses. It is true that breeders have concentrated on larger flowers and other characteristics to the detriment of scent. However, there are a few roses that are pleasantly fragrant and are widely available in the trade. Among the best for this quality at BBG are 'Chrysler Imperial' (medium dark red), 'Oklahoma' (dark red), 'Tiffany' (pink), 'Fragrant Cloud' (orange) and 'King's Ransom' (yellow).

Although there are no miniature roses in the Cranford garden, several of these tough little creatures have crept into the BBG rock garden. Easy to grow, the mini rose is fast gaining in popularity, for it remains small (most do not grow over 12 inches) and can find a home in a rose garden, perennial beds, a border, or in the foreground of a foundation planting. Like their big sisters, they come in all colors and are as hardy, if not hardier.

As a last step in preparation for the winter, one-third to one-half of the tops of the large rose bushes are cut off to protect the canes from autumn and winter wind, from breaking in an occasional snow, and reduce mildew for the next season. Mr. Malins then retires to the indoors, to plans and catalogs, to map out the Cranford Memorial Rose Garden for the next spring.

Hope for the American Chestnut?

YES, indeed, according to Richard A. Jaynes of the Connecticut Agricultural Experiment Station in New Haven. A less virulent strain of the fungus that ravaged our trees has been found in Europe. When injected in the American chestnut, it deprives the deadly common type of its strength. It appears most effective when an injection of MBC, a systemic fungicide related to benomyl, is made first. Dr. Jaynes, a cautiously optimist researcher who has worked with the chestnut for many years, stresses that it remains to be seen whether the mild strain can survive and spread in the wild here, providing natural inoculation as occurs in parts of Europe.

Chestnut blight is one of the six deadliest tree killers of the century, according to J. C. Carter of the Illinois Natural History Survey. In the August, 1975 *Journal of Arboriculture* he also cites dwarf mistletoe, white pine blister rust, elm phloem necrosis, Dutch elm disease and oak wilt.

Sickening News

From American Horticultural Society News & Views, March 1975

IF you're using the fungicide Thiram—marketed under the names arosam, tersam, and thylate—watch out: it may have a surprising side effect that you ought to know about. The chemical is related to a product known as Antabuse which is employed to curb drinking by making you sick when you drink. The Canadian Department of Agriculture has discovered that it's possible to take in enough Thiram while working with it to make you sick to your stomach (if you drink a cold beer after a hard day's work).

CHLORDANE AND SOME ALTERNATIVE INSECTICIDES

Silas S. Hagar

Do you know the chemical 1,2,3,4,5,6,7,8-octachloro-2, 3, 3a, 4, 7, 7a-hexarydro-7-methanoindane? The chances are you do, but under quite another name—chlordane, for it's been one of the most widely employed insecticides of the last quarter century. Chlordane has been used to control grubs of various beetles, ants, weevils, termites, chinch bugs and sod webworms. Veterinarians have also put it to work for the control of fleas, lice and ticks on animals. Because chlordane has been effective against so many kinds of pests, it has had a special place on the grower's shelf.

However, chlordane has long been a source of controversy. As some critics have pointed out, including the late Rachel Carson in *Silent Spring*, it is exceptionally slow to disappear from the soil once it has been applied. This quality has its practical benefits on farms and in home gardens, but it also raises the question of what long-term hazards may occur if applications are made repeatedly over a period of years.

More recently, chlordane has been in the news because of its purported carcinogenic effects, which have become a subject of some dispute even within the Environmental Protection Agency. In any event the Agency has proposed the banning of this insecticide for most purposes, and the time has come when gardeners must consider alternative insecticides. Since the cost of developing and registering a new insecticide may be between ten and twelve million dollars, it is unlikely that a single substitute for chlordane will come onto the market, even if it were chemically practical.

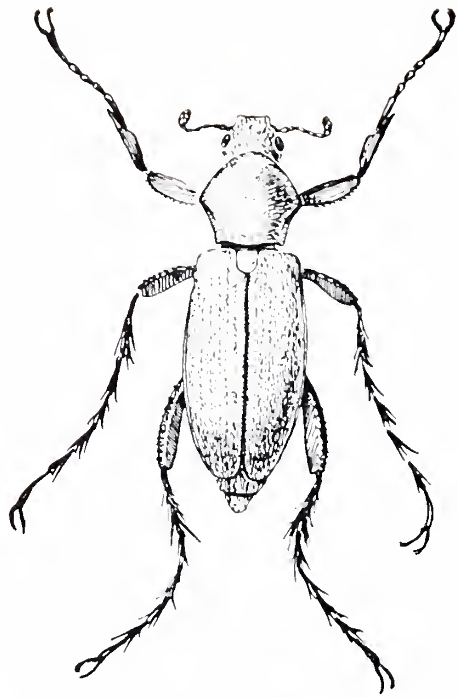
Chlordane was first patented in Great Britain in 1949 and later in the United States. Other related, more toxic, chemicals were also available during the past 20-25 years, including DDT, endrin and dieldrin. Many of these persistent, chlorinated hydrocarbons have either been banned by the Federal government or made unavailable to homeowners in various states due to their toxicity and potential adverse effects on the environment.

Where chlorinated hydrocarbons *must* be used to control certain grubs in the soil and some other types of insects, chlordane is the chemical of choice. It is, as of this writing, available to homeowners in the following percentages and for *specific* uses in New York State.

1. 5 percent granules in packages 20 lbs. or less. For turf insect control *only*.
2. 5 percent dust in packages 5 lbs. or less. For ant, termite, and turf insect control *only*.
3. 45 percent to 50 percent emulsifiable (liquid) in packages one quart or less. For ant, termite, taxus and Japanese weevil control and turf uses *only*.
4. 2 percent aerosol canister for household use.

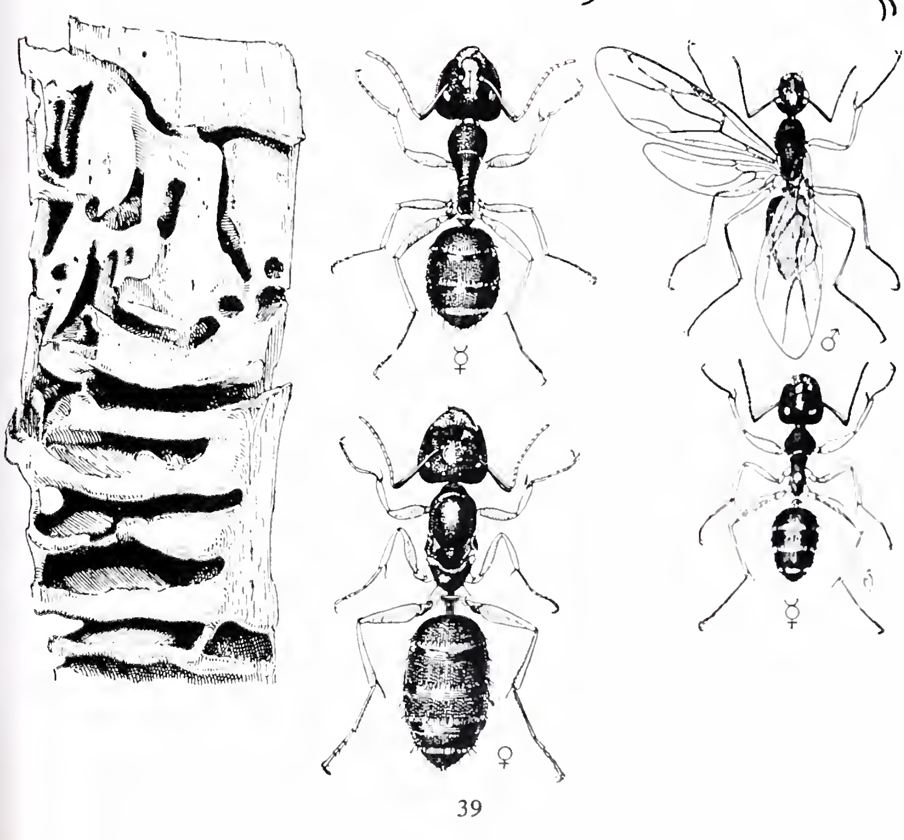
To obtain any one of these formulations, the homeowner or gardener must "sign" for these chemicals when purchased. Also, chlordane may not be used in fertilizer or pesticide mixtures (excluding aerosols). Residents of other states should consult their respective Cooperative Extension Service to obtain information on the use of this chemical.

Research has clearly shown that some grubs of Japanese beetles, Asiatic garden beetle and European chafer have become resistant to chlordane. Thus, substitutes must be used, even if it were not for the proposed EPA ban on most of the current uses of chlordane. Several chemicals, or biological control materials, are available that do not persist for long periods of time and will control the insects previously mentioned. They are listed



Chinch bug **(above)**; rose chafer **(right)**; and the carpenter ant **(below)**. Shown are its galleries in dead wood where young are reared; also neuter workers, a winged male and egg-laying female.

U.S. Dept. of Agriculture



in the accompanying table.

Diazinon applied in granular form or as a soil drench around the base of rhododendron, azalea, pieris, taxus or kalmia *may* help to eliminate the grub stage of black vine weevils (taxus weevils) and strawberry-vine weevils. Japanese weevils that feed on many species, especially members of the Heath Family (Ericaceae), can be controlled by spraying with carbaryl (Sevin).

Subterranean termites and carpenter ants in or around the home pose a problem. Carpenter ants can usually be eliminated by applying pesticides to the wood in which they are working. Two percent malathion or 0.5 percent dichlorvos (Vapona) or 0.5 percent lindane are effective. (*Note:* Lindane is not cleared for this purpose in New York State.) These can be applied with a sprayer. If termites are present as colonies in wood, it is advisable to consult a reputable pest-control operator or your Cooperative Extension Agent for control measures.

Further research and trial programs will probably reveal other pesticides that are less hazardous, perhaps less expensive and provide more effective control of pests. The home gardener should be aware that many pesticides are *potentially* hazardous *if* they are used indiscriminately. Instructions for their use should be followed closely.

Insect Control in Turf

Pest	*Recommendation*	*Comments*
Grubs (chlorinated-hydrocarbon resistant)	Diazinon—E, W, G or Dursban—E, G	Apply 1 inch of water immeditely if used against grubs. Treat annually in Aug. Water 48 hours later if used against sod webworms. Granular formulation most effective.
Japanese beetle grubs (*only*)	Milky Disease powder (spores of *Bacillus popilliae*). Use 8 lb/acre.	Grubs must be present to spread and maintain disease; do not use on areas treated with insecticides. Useful on large, marginal, turf areas.
Hyperodes weevil	Diazinon—E, W, G or Dursban—E, G	Treat with Diazinon in mid-April and mid-May. With Dursban, treat once about May 1.
Sod Webworms, Cutworms	Carbaryl (Sevin)—F, S, W, G or Diazinon—E, W, G or Dursban—E, G or Akton—E	Treat in the evening. Do not water in treatments. Apply spray with lower rates of water. Do not cut grass 3 days after treatment. Avoid spraying before rain but if aimed also at grubs, water in 48-72 hours after treatment.
Chinch Bug	Carbaryl—F, W, G or Aspon—E, G or Dursban—E, G or Akton—E	Water lawn prior to treatment. Water in granular materials after application. Carbaryl and Aspon least hazardous, diazinon moderately toxic. Apply treatment in early June. A 2nd treatment may be necessary 2-3 weeks later, except Aspon.
Ants, Lawn Billbugs, Millipedes, Earwigs	Diazinon—E, W, G	Treat mounds, according to label. Control of other pests in lawns should also control ants.

Note: Instructions for applying pesticides will be on the label. Please follow these instructions carefully. E = emulsion; F = flowable; S = sprayable; W = wettable powder; G = granular.

Researchers say some vines grow toward darkness

TREE-AIMING TRAIT OF PLANTS FOUND

Jane E. Brody

From the NEW YORK TIMES, Nov. 19, 1975. © The New York Times Co.
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WALKING through the tropical forest in Costa Rica, a Florida sociologist who ordinarily studies insects noticed that vine seedlings on the forest floor were always pointed toward a nearby tree. The snake-like vines converged like the spokes of a wheel with the tree as the hub, as if they "knew" precisely where the tree was.

His curiosity piqued, the insect ecologist, Dr. Donald R. Strong Jr., temporarily abandoned the animal kingdom and began a series of measurements and experiments that led him to discover a previously unrecognized behavioral trait of some plants.

The phenomenon, which he and his collaborator, Thomas S. Ray Jr., have named "skototropism"—literally, growing toward darkness—is a special mechanism some vines have evolved to enable them to find a tree on which to climb. Most plants grow phototropically, that is, toward the light.

As described in the Nov. 21 issue of the journal SCIENCE, the vine seedlings, in effect, stick their heads up, look around for the darkest nearby object is likely to be a tree suitable for climbing.

A Reach of 27.5 Inches

According to the studies of the Florida State University researchers, the vine *Philodendron giganteum* can use skototropism from distances of 27.5 inches away to find its host tree. Once the vine reaches the tree and begins climbing, it abandons its skototropic behavior and becomes photographic, putting out leaves to manufacture food through photosynthesis.

Before this report, a wide range of explanations had been offered to explain how a vine knows where to go to climb. Among them were negative phototropism (growing away from the light), random searching and negative geotropism (growing against the pull of gravity).

But none, Dr. Strong said in an interview yesterday, were adequate to account for what he observed.

"Farmers have long known that if you put a pole near a bean plant, the bean will find the pole and grow up it," he remarked. "But apparently scientists never picked up on this fact, let alone why it happens. Even Darwin, an impeccable scientist who rarely missed anything, failed in his study of vines to do the kind of experiment that would have led him to recognize skototropism."

In combining the scientific literature, Dr. Strong and Mr. Ray, an undergraduate majoring in biological science, found only one author who gathered data as demonstrating skototropism. In 1925, A. Bierce described a vine as pursuing a stake that was moved daily to a different position relative to the sun.

However, the author offered this, not as evidence of skototropism, but as "proof" of the "consciousness of plants," "that they think" and that "plants belong to the philosopher class."

In the Costa Rican forest, the Florida researchers observed thousands of bright green seedlings with tiny scales for leaves "creeping inward from all sides of the tree" along a bed of "brown leaf litter." Since the seedlings were growing from all directions, irrespective of where the light was brightest, they surmised that negative phototropism could not account for the behavior.

Preference for Low Light

In negative phototropism, the plant would grow at a 180-degree angle away from the light. Some plants, such as the coleus, which prefer low light conditions, will display negative phototropism when exposed to very bright light.

The Florida researchers took measurements in the field and designed experiments that they say clearly showed that the seedlings of *Philodendron giganteum*, a relative of the split-leaf philodendron, a common house plant, actually seek out darkness irrespective of where the light may be brightest.

In the experiments, seedlings were placed at varying distances from panels of different sizes and degrees of darkness. The tests were done on the floor of the dense, shaded tropical forest, where the vines live. In each case, the seedlings turned toward the darker panels and slowly grew toward them.

As the seedlings grow, they keep their heads up "like radar," Dr. Strong said, bending and elongating just behind the tip of the green shoot. The journey toward the host tree is torturous, with the seedlings often distracted by twigs or other debris that temporarily loom large and dark on their immediate horizons.

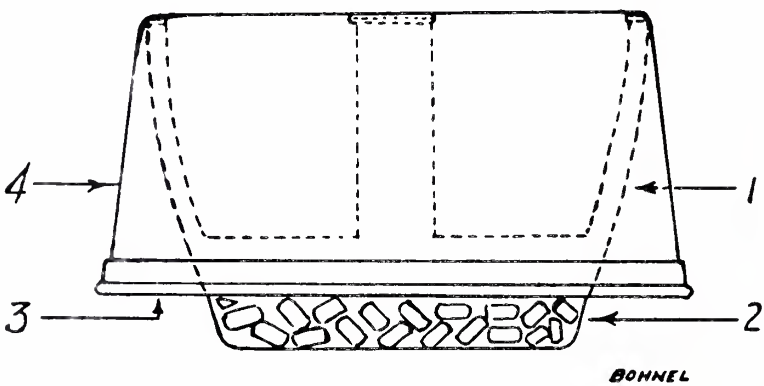
Relatively few of the seedlings ever make it to a host tree, to which they cling like parasites, Dr. Strong said. And, he added, some tropical trees seem to have evolved a means of avoiding the burden of vines—some periodically shed their bark, simultaneously losing the clinging vines; others have light bark that does not attract a vine that is looking for something tall and dark.

Novel Slug Trap

From American Rhododendron Society BULLETIN, Vol. 29, No. 1

1. Small size margarine plastic container for holding Slug Bait: 4″ wide at top x 2¼″ high x 2⅜″ wide at bottom. Cut out on dotted lines leaving four ½″ wide pillars to sustain plastic protective cover.
2. Slug Bait.
3. Entrance for Slugs.
4. Rain-free protective plastic trap cover, margarine plastic container: 4″ wide at top x 1⅞″ high x 3½″ wide at bottom. Keeps Slug Bait dry or Beer in a larger edition from becoming diluted from rain.

A larger size may be constructed from larger plastic containers to contain Beer which is also used effectively as bait for the destruction of Slugs.
—*Emil V. Bohnel*



WHO'S PROTECTING ENDANGERED PLANTS?

Jane Herrman

SINCE the publication of the Smithsonian Institution's "Report on Endangered and Threatened Plant Species of the United States" and its subsequent appearance as part of the Federal Register (Vol. 40 No. 127, July 1, 1975), new attention has been focused on the problem of endangered plants in this country. Up to this point it seems that even ardent conservationists were more concerned with the status of members of the animal kingdom, so this recent look at flora is well deserved. However, we are a long way off from seeing any of the Smithsonian's suggestions turned into Federal law; this at the expense of many plants which may already be on their way to extinction.

It is with this in mind that an attempt was made to find out if there were any official listings by the fifty states of endangered plants and regulation against their destruction. Letters were sent to government agencies in all of the states in the hope that a compilation and comparison of lists could be made. The results have been discouraging.

Problems arose at the offset of the project. It was difficult in some cases finding out which state agency to contact. Many states have no departments of Natural Resources or Conservation, and some do not even have departments of Forestry or Fish and Wildlife. Four letters were returned unopened due to insufficient address or because the department had moved. Nine states did not reply at all. In two cases incorrect information was received: one answered with a list of dangerous (poisonous) plants instead of endangered ones. Seventeen states replied with no official or unofficial state list, although some of these noted that a list was forthcoming or suggested that the Smithsonian Report be consulted. Only eighteen states sent any sort of list, and of these just four (New York, Vermont, Florida and Wisconsin) appear to have lists which are both "official" and clearly enforceable as law. The other lists have been issued by universities, garden clubs, extension services and conservation organizations.

Attempts to compare the lists produced further complications, ranging from typographical errors to varying uses of common names. Obviously, it does not make much sense to compare the flora of New Hampshire with that of Arizona in order to obtain a nationwide consensus on what is rare or endangered. However, among the lists received, which were largely from the eastern part of the United States, there are certain species or plant families which appear repeatedly.

Plants of Increasing Rarity

Endangered orchids are mentioned time after time. They include *Calopogon*, fairy-slipper (*Calypso*), lady's slipper (*Cypripedium*), *Pogonia* and twayblade (*Listera*).

Although many ferns are common in the East, others occur infrequently, including adder's-tongue (*Ophioglossum*), spleenwort (*Asplenium*), walking-leaf (*Camptosorus*), *Woodsia* and grape fern (*Botrichium*). Another group of non-flowering plants, the *Lycopodium* genus, known to gardeners by such names as ground-pine, ground-fern and running-evergreen, is becoming rare in many areas. The long strands of them that are found creeping along the forest floor are easy to uproot and have long been popular in terrariums and as Christmas decorations.

Among the well known wildflowers that appear on several lists are ginseng (*Panax quinquefolius*), trailing-arbutus (*Epigaea repens*) and bloodroot (*Sanguinaria*), as well as certain species of *Trillium*, *Gentiana* and pipsissewa (*Chimaphila*). Woody plants frequently mentioned are native *Rhododendron* (including azalea), moun-

The pink lady's slipper (*Cypripedium acaule*) is one the native orchid species included among plants of increasing rarity.

Marjorie J. Dietz

tain-laurel and its kin (*Kalmia*) and holly (*Ilex*).

Why Plants Become Rare

Even this brief listing points out the many problems that must be dealt with. The first is that of changing environments, brought on either by natural forces or by man. Whether "natural" succession should be retarded is a somewhat philosophical question, but more often the real question is whether a bog should be drained to build a shopping center, a forest destroyed to put up condominiums, or a dam constructed to generate electrical power, all at the expense of plant life.

The second problem is that of the private collector. Largely as a result of the increased popularity of growing plants in the home, many people are uprooting rare orchids and ferns as well as other specimens for use as pot plants or in terrariums, frequently taking more than they will need and not realizing that many of these plants will not grow well indoors.

The third and most serious problem is that of exploitation, a case in which large numbers of plants are being taken for commercial purposes with no regard for the survival of the species. Groups particularly affected by this "make-a-quick-buck" attitude are the orchids, ferns, cacti and insectivorous plants, including pitcher plants, Venus fly traps and sundews. From the information received, there seems to be little state protection of the latter two groups. Plants such as ginseng, which is used for its purported medicinal qualities, have become endangered simply because of their marketability. It is only through stringent laws and enforcement that a halt can be put to this sort of destruction.

Virtually all states have unintentional plant-protection regulations inherent in their laws concerning trespassing and stealing on private property. However, many endangered plants grow on state or federal land where there may be no effective protection. Before specific laws can be drawn up and enforced, a better job of education is needed. State governments can join with conservation groups, botanic gardens and other organizations to make people more aware of the endangered plant situation. Lists that do exist should be honed and made more readily available to interested citizens. Land containing rare plants might be acquired by the state, as it has in all too few instances, and set aside as a wildflower preserve. We all must realize that having a variety of plants is of the upmost importance in nature, that each plant occupies its own very specific niche, and that by obliterating even the seemingly least important species, we may be indirectly injuring ourselves.

The list which follows does not purport to be a complete catalog. It is based on inquiries made to the appropriate agencies in the fifty states, and responses varied considerably.

If readers can supply further information concerning their state's regulations, they are invited to contact the author in care of the Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, N.Y. 11225.

State	*Responsible for List*	*State Law*
Alabama	Presented by Garden Club of Alabama; published by Alabama Department of Conservation and Natural Resources	Trespassing
Arkansas	Arkansas Natural Area Plan, Gary E. Tucker, Arkansas Polytechnic College	Unknown
Florida	State Law, 1971	Unlawful to carry or convey on public highway or sell in any place
Georgia	W. H. Duncan, University of Georgia	Unknown
Idaho	"Report of the Natural Areas Workshop," C. A. Wellner and F. D. Johnson, College of Forestry, Wildlife and Range Sciences, University of Idaho	Unknown
Michigan	John Beamon, Michigan State University	Fine or imprisonment
Minnesota	G. B. Ownbey, University of Minnesota	Unknown
Missouri	Missouri Department of Conservation and U.S. Department of Agriculture, Soil Conservation Service (1974)	Unknown
New Hampshire	Society for the Protection of New Hampshire Forests	Trespassing
New Jersey	D. E. Fairbrothers and M. Y. Hough, Department of Botany, Rutgers University	Unknown
New York	State Law, September 1, 1974	No picking or damaging of plants on private or public property without permission. $25 fine.
North Carolina	North Carolina State University	Unknown
Tennessee	Candidate species list by A. J. Sharp, Botany Department, University of Tennessee	Unknown
Texas	List by Texas Organization for Endangered Species	Unknown
Vermont	State Law, June 6, 1975	Permit or permission needed on public or private land. Picking limited to one plant or two cuttings, and only for scientific purposes.
Virginia	Co-operative Extension Service and Virginia Federation of Garden Clubs	Unknown
West Virginia	"Rare and Endangered Plant Species in West Virginia" by West Virginia Department of Agriculture	Unknown
Wisconsin	State Law	Endangered plants cannot be picked or dug.

COLONIAL GARDENING

Zona Sparks

On May 7, 1776 Thomas Jefferson set out from His Majesty's Royal Colony of Virginia for Philadelphia, where the Second Continental Congress was locked in debate on the searing question of independence. Lexington and Concord, Bunker Hill, the burning of Norfolk, the British evacuation of Boston seemed far away indeed as he paused for a farewell glimpse of his beloved Monticello. Apple blossoms lit the hillside orchard shared with the pears, cherries, plums, peaches, nectarines, pomegranates, figs and walnuts he had planted in the spring of 1769. The heavy tranquil scent of sweet-bay filled the air while beds of iris waved like flags in the breeze.

Jefferson rode north with the spring, past banks of rhododendron and dogwood, pastures ablaze with dandelions and phlox, through towns glorified by the handsome blossoms of the horse-chestnut tree and borders of nodding narcissus. He may even have glimpsed in some woodland glade the shy white flower of the "rheumatism root" which was eventually given the botanical name *Jeffersonia diphylla* in his honor.

Indian Horticulture

It was a far different landscape from that which greeted the first European explorers of the New World, for most of the fruits, along with the horse chestnut, dandelion and narcissus, had been introduced from the Old World. However, "North America is a natural garden," comments historian Ulysses P. Hedrick, "More than 200 species of tree, bush, vine and small fruits were in common use by the Indians when the Whites came. Besides these, there were at least 50 varieties of nuts and an even greater number of herbaceous plants."—*A History of Horticulture in America to 1860.*

Indian horticulture was at once primitive and sophisticated—primitive in the Stone-Age tools and hand cultivation methods that were used, sophisticated in certain ecological matters and in the plant selection that had brought the maize-bean-squash food group from a remote ancestry in Central and South America to the east coast of the continent. The Iroquois in New York grew at least a dozen varieties of corn and ten varieties of climbing beans, along with squash, pumpkins, gourds and melons. These were planted together then, as they sometimes are now, with the beans climbing the corn stalks (and contributing nitrogen to the soil) and the squash hugging the ground, preserving moisture and crowding out weeds.

The Indians were as quick to adopt the plants of Europe as were Europeans to adopt tobacco and other contributions of the New World. The peas that were introduced to Isabella Island by Columbus in 1493 had, by the time of Cartier's explorations in 1535 reached the Indians as far north as Montreal. So had the cucumbers brought to Haiti in 1494. Spanish missionaries brought many European fruits and vegetables, and by the time of the founding of Jamestown in 1607 Indian orchards of apples and peaches reached north to Canada and west to Arkansas and Texas.

What the Settlers Planted

Peaches and apples became an important economic factor in the lives of the early colonists, not merely as fresh and dried fruits, but as cider and brandy. Cider (or cyder), the common beverage of the period, was used for barter by cash-short colonists. It paid the cobbler, the doctor, the minister, the lawyer and was exported to the West Indies in return for spices and tropical produce. A single family often produced between 50 and 75 barrels of cider each fall for home consumption and barter.

Possibly the most famous harvest in America was that of the autumn of 1621

The Bettmann Archive, Inc

Mound builders gathering their crops. Many tribes planted beans among corn so the beans could climb the corn stalks. Melons and squash vines were part of the same patch.

in Plymouth—the "first Thanksgiving." On March 7 (old style) of that year the Pilgrims had planted the garden seeds brought from home, along with Indian staples and roses. But, if pumpkin pie was served at the first Thanksgiving feast, it was probably made without pastry. The early New England pumpkin pie was made by removing the seeds from the pumpkin, stuffing the cavity with apples, spices, sugar and milk, and baking it whole.

The first colonial orchard in Massachusetts was planted no later than 1625 in Boston at what is now the corner of Beacon and Charles Street by a clergyman named Blaxton. Even earlier, in 1604, a Frenchman named Sieur de Monts founded an unsuccessful settlement on St. Croix Island, Maine. Some of the apple and pear trees he planted there stood for two centuries.

New World orchards were not without natural enemies. "Their fruit trees," wrote John Josselyn in about 1674, "are subject to two diseases, the Meazeles, which is when they are burned and scotched by the sun, and Louziness, when the Woodpeckers eat holes in their bark. The way to cure them when they are louzy is to bore a hole in the main root with an Augur, and pour in a quantity of Brandie or Rhum, and then stop it up with a pin made of the same tree."

Ornamental Plants

Though the earliest settlers had time for little more than basic food crops, a longing for the familiar flowers of the English countryside soon spurred a lively trade in seeds between London and the colonies. A short decade after the first harvest at Plymouth John Winthrop the Younger placed an order with his seedsman for no fewer than 57 varieties of vegetables and flowers, including "cullumbine, hollihock, walflower, mallow, marigold, popey, stock, tansy, violet, and flower of the sonne." Many flowers—poppy, rose, peony, marigold and saffron—were valued as much for their medicinal attributes as for their beauty.

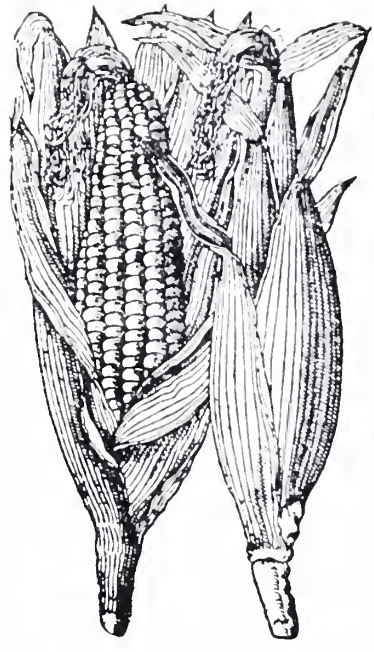
One of the earliest ornamentals, the English barberry (*Berberis vulgaris*), which was also grown for its edible fruits, nearly provoked disaster. It turned out to be an intermediary host for stem rust in wheat, and great pains were taken to eradicate it. In the first New World legislation to control plant disease, Massachusetts in 1754 passed a law "to prevent damage to English grain arising from barberry bushes in the vicinity of grain fields." Over the longer term barberry was the winner, for it is still a common sight in the long-abandoned fields of New England.

The Dutch and French Huguenots brought the gardening traditions of the Low Countries to the Hudson and Mohawk valleys. In New Amsterdam, Governor Peter Stuyvesant grew gillyflowers, roses, tulips, lilies, anemones and native flowers, as well as peaches, apples and pears. It is said that a pear tree planted by Stuyvesant near the church of St. Mark in the Bouwerie stood for 220 years (until 1866). Dutch peaches were responsible for the Massacre of 1655. An Indian woman caught stealing peaches was killed by the Dutch. The Indians retaliated by killing or capturing some 200 settlers.

The Dutch favored formal arrangements, with at least one sundial in every garden, and an abundance of yew and boxwood clipped into the shape of animals. The topiary was carried to such excess, says U. P. Hedrick, that "Dutch gardening" became the laughingstock of the times. When New Amsterdam became New York, English gardening took over, and with it came the planting of street trees. Sycamore (*Platanus occidentalis*), black locust (*Robinia pseudo-acacia*), linden and elm were the favorites. When Peter Kalm visited the city in 1748, he commented, "I found it extremely pleasant to walk in the town, for it seemed like a garden."

Often overlooked is the contribution of French and British soldiers to gardening in America. The five European wars that occurred between 1689 and 1763 spilled over into the colonies as the French and Indian wars. To provide protection of

The Iroquois Indians in New York were growing at least a dozen varieties of corn (maize), a crop that had reached the East Coast from Central and South America, along with beans and squash.



territory and settlers, both the British and the French built numerous forts. Often the soldiers stationed at these forts had more time to plant and tend ornamental gardens than did the settlers. A fort garden might include a fish pond, bowling green, elaborate flower gardens as well as orchards and kitchen gardens.

By 1760 some 100 British forts maintained gardens. Disputes over the location of these historic forts have sometimes been settled by the tell-tale presence of garden "escapes" such as bouncing bet, chamomile or butter and eggs. French forts sometimes drew on the Palace of Versailles for inspiration. Fort Carillon's Jarden du Foi was laid out in 1756 or 7 with a "vista made thru the wood to extend the prospect from the fort." The name of the fort was soon changed by the British to Ticonderoga.

England and Holland stayed the chief source of plants and seeds for the colonies, even after the establishment of the first nursery in New York in 1737. Until the development of a colonial press, England was also the main source of horticultural literature. John Smith's *Profit and Pleasure United* made its appearance in London in 1684 and was reprinted in America in 1718. The full title, almost a chapter in itself, was "The Husbandman's Magazene. Beaing a treatise of horses, mares, colts, oxen, cows, calves, sheep, swine, goats: with directions for their breeding and ordering . . . together with plain rules for improving arable and pasture lands . . . sowing and harvesting: The management improvement and preservation of fruit trees, plants and flowers . . . flax and hemp . . . bees. with cutts." Betty Langley's *New Principles of Gardening* (London, 1728) was the text from which George Washington laid out the gardens of Mt. Vernon.

Nicholas Culpepper's *The English Physician Enlarged* was a common herbal among both doctors and householders. The arts of gardening and healing, of course, have gone hand in hand from the beginning of time. In 1724 Virginia physician John Tennent published *Every Man His Own Doctor,* "a plain and easy Means for Persons to cure themselves by medicines grown in America." It was announced as a book for "those who can't afford to dye by the Hand of a Doctor."

American gardening almanacs appeared

sporadically during the 17th century, but it remained for Benjamin Franklin, writing under the pseudonym of Richard Saunders, to launch a regular systematic review of useful gardening information in 1732. *Poor Richard's Almanac* was published for 25 years. It was Franklin, too, who in 1744 organized the American Philosophical Society. Among its purposes was to study "all new discovered plants, herbs, trees, roots and their virtues, uses, etc.; methods of propagating them . . ."

The publication of Carl Linnaeus' *Genera Plantarum* in 1737 stirred great excitement on both sides of the Atlantic, for it provided the first systematic approach to the classification of both old and new world plants. The Swedish Academy of Sciences, eager to discover useful food, fiber and dye plants suited to its rigorous climate dispatched a 32-year-old student of Linnaeus on a 3½-year voyage of botanical discovery in America. Arriving in Philadelphia in September, 1748, Peter Kalm set out at once to enlist the aid of Franklin and John Bartram, the great self-taught naturalist who 20 years earlier had launched America's first botanic garden on five acres along the Schuylkill River.

A keen observer of people and customs as well as of plants, Kalm described water pollution in Albany, the use of poison-ivy sap as an indelible laundry marking ink, and the meanness and stinginess of Thomas Penn, then the proprietor of Pennsylvania. He also collected some 300 American and Canadian species for the gardens at Upsala. And during his first visit to New York he noted prophetically, "I have been told . . . that the English colonies in North America, in the space of thirty or fifty years, would be able to form a state by themselves entirely independent of Old England." Kalm's *Travels in North America* remains a classic social commentary and horticultural travel guide to colonial America.

The End of an Era

Horticulture, agriculture and botany became consuming passions in the New World. "I know no source of amusement and health equal to botany and natural history," wrote Thomas Jefferson some years after the founding of the republic. "Botany I rank with the most valuable sciences, whether we consider its subjects as furnishing the principal subsistence of life to man and beast, delicious varieties for our tables, refreshments from our orchards, the adornments of our flower-borders, shade and perfume of our groves, materials for our buildings, or medicaments for our bodies."

The saddle bags of post riders bulged with slips, seeds and cuttings sent from one friend to another. Scarcely a ship left Philadelphia without a consignment of seeds and plants from William Bartram for the gardens of Europe. Arriving packets brought from the far corners of the earth Chinese juniper, Persian lilac, English holly, Scotch broom, Russian-olive, Austrian pine, alpine currant, Norway maple, cedar-of-Lebanon, destined perhaps for John Adams' farm in Braintree, for James Madison's Montpelier, Jefferson's Monticello, or Washington's Mt. Vernon. Yet the Founding Fathers had never set eyes on a camellia, poinsettia, Easter lily, dahlia, forsythia, Lombardy poplar, ailanthus or ginkgo. Despite the familiarity of these plants today they were all unknown at the time of the American Revolution.

July 4, 1776 marked the end of the "colonial" garden, the beginning of a new age of exploration, invention and discovery. In September Thomas Jefferson returned to the State of Virginia to attend his harvest, draft plans for the government of the new Commonwealth of Virginia, and order new trees for his orchard. He wanted to plant apricot, almond, olive and chinaberry.

"Men are like plants," wrote Hector St. John Crevecoeur on the eve of the War for Independence, "the goodness and flavour of the fruit proceeds from the peculiar soil and exposition in which they grow. . . . Here individuals of all nations are melted into a new race of men, whose labours and posterity will one day cause great changes in the world."

ENVIRONMENTAL NOTES

• The Pfizer Company, one of America's largest pharmaceutical firms, had a problem of what to do with all the mycelium by-product from the manufacture of penicillin and other antibiotics. Professors William A. Niering and Sally Taylor of Connecticut College (New London) decided to do controlled tests on the mycelium from Pfizer's Groton plant to determine what effect it would have on the growth of vegetables and ornamentals. The results were encouraging, particularly on soybeans, a crop of increasing importance because of their protein content. Peppers, tomatoes, carrots, cucumbers, and beans performed at peak level in soil enriched with just mycelium, while many other kinds of plants, including ornamentals such as dogwood, yew and mountain-laurel, grew best when the mycelium was mixed with a commercial fertilizer.

• The sperm whale became an endangered species in recent years partly because its oil served as a valuable high-pressure lubricant in automatic transmissions and other machines. However, an evergreen shrub from the southwestern United States, jojoba (*Simmondsia chinensis*), related to boxwood, may be coming to the rescue. According to the National Academy of Sciences, an oil extracted from its seeds has been found to be an excellent sperm-oil substitute.

• Urban gardens immediately next to highly congested streets may not be the safest place to grow vegetables, according to Gil Friend, co-director of the Washington-based Institute for Local Self-Reliance. Preliminary tests conducted in Washington, St. Louis, Boston and New York suggest a build-up in lead, presumably from automobile exhausts. Friend remarked that the problem in St. Louis appears severe on some sites, in New York minimal. Much of the metal can be washed off in a simple vinegar solution. The amount of lead varies considerably, and more extensive tests are planned.

• According to Prince Bernhardt of the Netherlands, in a talk given at the New York Botanical Garden (Bronx), October 1, 1975, "today our exploding population is being fed largely by about 15 species [of plants]. And in most cases we are relying on cultivated varieties with a narrow genetic base, which combine high productivity with great vulnerability to pests and shortage of fertilizers or water."

What's in a Name

NEW gardeners are sometimes confused by the use of botanical names and shy away from their use, but the precision afforded by them is important to botanists—and horticulturists. Everyone in the field can think of many examples. Several years ago BBG had an exhibit at a New York flower show and was nearly deprived of the top award because Oriental bittersweet *(Celastrus orbiculatus)* was displayed. The judges hesitated because the name bittersweet appeared on a local protected list, but with no botanical name attached. The bittersweet of the eastern United States, *Celastrus scandens,* is uncommon in many areas and should not be picked, but its Asiatic kin has become widely naturalized and is little more than a weed, albeit a very attractive one, along the roadside.

Soil is the basis of all gardening, but is frequently given far less thought than seeds, tools, fertilizers and the other essentials

SOIL

R. Milton Carleton

From HORTICULTURE, Jan. 1975

SOIL is perhaps the most complex and least understood of any substance with which man works and is vital to the survival of practically every living organism, animal or vegetable, from microscopic bacteria and fungi to the great redwoods along with the giants of the animal world. Of all the living creatures man alone manipulates and modifies the soil to better serve him. Since long before the beginnings of recorded history he has managed to work it and improve its yield of food and fiber beyond those possible in the wild.

But because of his lack of understanding of the actions and reactions within the soil, false concepts have arisen which stand in the way of both further improvement and of conservation of its productive capacity. The first of these concepts is the idea that soils serve only as a supporting medium for plants—a mechanical mixture of sand, silt and clay to which plant food elements can be added much as money is deposited in a bank and withdrawn.

What is evident here is a lack of appreciation for two vital elements without which a true soil is impossible. The first is organic matter, a subject so complex that the late Dr. Selman Waksman once wrote a book of nearly 1,000 pages on a single element of organic matter, humus, in which he had to leave almost as many questions unanswered as he answered. An example of the complexity of this one substance is lignin which enters into its genesis . (I have discussed lignin with two recognized authorities, only to find that they differ sharply on what it really contains.)

The second ignored element, also a vital part of soil, is biologic, microorganisms, the tiny bits of life that in turn make soil a living thing. Someone once said that soil management is almost entirely the culture of bacteria. If we add to that other forms of soil life such as fungi and mycorrhizae, protozoa, actinomyces and rotifers, it about sums up their importance in true soil.

The number of these tiny bits of life are almost impossible to grasp. Turn over a spadeful of rich garden soil and in that single clod of earth you will disturb more living organisms than there are human beings in the world. In an acre of cultivated farmland, guess what the count would be. In spite of their awesome abundance and their contribution to soil fertility they are all but ignored, while the much less important earthworms are blown up into fetish proportions.

A common mistake is that both earthworms and microorganisms are responsible for rich soil. The ruth is neither contributes any richness—only green plants are able to make starches and sugars, the energy foods upon which all living matter depends, through the magical process of photosynthesis by which they take carbon from the air and water from the earth, and combine them with energy from the sun to produce the basic ingredients of life.

Instead of circulating richness, animal organisms use the energy stored in the soil for their life processes. How, then, do they make the soil suitable for plants? One of their most important functions is the digestion of highly complex organic compounds using part of these for their own energy needs and expelling the unused parts in simpler forms.

In spite of all the claims made for the importance of pure organic matter in

Peat moss is one of the most accessible sources of humus for most home gardeners. After spreading over the ground, it should be incorporated into the soil by forking or tilling.
George Taloumis

gardening no one has ever seen a cabbage eat a hamburger. Plants can only absorb nutrients in solution, in near-elemental form. They do not have digestive systems capable of using highly complex organic matter. Every gardener, whether an organic enthusiast or non-believer, must understand this need for the presence of microorganisms in his soil if it is to produce at capacity.

One problem faced by those who rely entirely upon organic fertilizers is that microorganisms do not release plant nutrients until the soil warms up. In some sections of the country, such as northern New England, this does not occur until mid- or late June. Bacteria and fungi, for example, are all but dormant until the soil reaches a temperature of at least 60 degrees. (In the spring of 1974, for instance, the soil temperature in Rockland, Maine, was 55 degrees on June 17.) Thus, hardy annuals and vegetables, seeded as soon as the soil was workable, had to rely upon what limited supplies of soluble plant foods were left over from the previous fall.

Therefore, if soluble nitrogen from chemical fertilizers is applied in early spring, plant growth is stimulated at a time when such growth is most important. Lawns, in particular, need this treatment, since bluegrasses, bents and fescues begin active growth at 42 degrees, not 60. However, even though nutrients from organic matter are not available early, this in no way diminishes the importance of them in the soil.

Perhaps the greatest service of microorganisms to the gardener and farmer is the way in which they conserve plant food elements. When we apply a fertilizer, whether organic or chemical, to soil only a fraction of it can be used directly. In spite of the complex mass of roots a plant produces, they do not occupy more than a small fraction of the soil in which it grows. As a result any soluble food elements can be lost quickly in water draining from around the plant. This loss is slowed up in soils high in organic matter, but microorganisms are even more efficient as conservators, for they occupy every minute space in the soil, absorb any soluble nutrients and use them for their own purposes.

When absorbed in this way, although some energy is used and is lost to higher plants, much of it becomes a part of the living cells. Fortunately for gardeners, however, as well as for the plants, microorganisms have an extremely short life cycle and as they die they release the food or energy they acquired and it is again available to garden plants.

A word that has been more or less lost in recent times is tilth. In a sense this means tillable but it has further meaning as well. A soil in good tilth not only turns readily under the plow or spade but when not too wet or too dry crumbles into a spongy mass which allows both air water to penetrate, yet does not drown out following heavy rains.

Unfortunately, practically all gardeners are forced to use what space and soil they own. To bring what earth one has up to gardener's loam standards calls for the use of materials and tillage practices which will improve existing sand, clay or silt.

A Simple Wash Test

Although the horticultural departments of state universities will usually test for fertility, they seldom recommend treatment to improve the texture and structure of problem soils. A simple wash test can be made with a sample of the soil, a half-gallon Mason jar and water. Heavy clay is difficult because the particles are tightly bound to each other but this bond can be broken by adding two level tablespoons of nitrate of soda to the wash test.

Put a half cup of the soil into the jar and then enough water to half fill the container. Tighten the jar lid and swirl the water for at least a half minute. Allow the soil to settle. Then swirl again. Repeat several times until the various fractions separate into definite layers. Some of the clay particles may not settle out for days but form colloidal suspensions. Yet, with each shaking, more and more coarse particles, such as sand and gravel, will settle below, while the lighter clay particles will form the top layer, with silt and organic materials between. True, the larger organic particles may settle out in an erratic way but they can always be identified by their fibrous structure.

Sandy soil contains less than 15% of clay or silt. Whether they are fine, medium or coarse, sandy particles can be readily felt by rubbing them between the fingers. About the only way to improve sandy soil is to add organic matter and more organic matter. The amount of such material a sandy soil can absorb is amazing. If this added matter simply disappears without forming a layer capable of holding water and supporting microorganisms, the only remedy is to form an impermeable layer from 12 to 18 inches below the surface to stop the downward movement.

In small areas this can be done, although at considerable expense, by removing the sand, laying down a sheet of plastic at least 2 mils thick and replacing the soil over it. In time a rich subsoil will build up just above the plastic, gradually rising to the surface.

Clay presents the most difficult problem of all, however. Yet, when modified it can produce a true loam, if enough silt and sand are mixed with it. The problem is how to separate the microscopically-fine clay particles so they do not form a barrier to the penetration of roots, water and air. A remedy often recommended for this is the addition of sand but, if sand alone is used, the combination can be worse than before. Unless the gardener can afford and is willing to add one part of sand to two parts of clay (a 2-inch layer of sand worked into 4 inches of soil) the clay particles may fill all the spaces between the sand and the result is a mixture resembling concrete.

Use of Lime

The ideal gardener's loam should contain ⅓ each of sand, silt and clay by volume but like so many theoretical ideals it is seldom reached. So long as water penetration, aeration and a satisfactory home for roots results, a less expensive solution can be used. In soils that need lime one of the best ways to loosen heavy clay is to apply ground limestone. This can be either agricultural lime or the fine grade of crushed limestone used for topping driveways. An inch or two of such material, for example, is useful for supplying calcium, raising the soil's pH (or reducing the acidity) and at the same time opening up a tight clay.

Lime works by pulling the clay particles into floccules or tufts. In theory, one particle of lime attracts and holds eight particles of clay, resulting in a looser soil. Try a 1-inch layer worked into the upper 6 inches at first, adding more at the

George Taloumis

Most gardeners must use what space and soil they own, but a power tiller helps in any case.

next digging or plowing if the clay is still sticky.

The addition of liberal amounts of organic matter will also loosen heavy clay. This is particularly effective if it follows the application of limestone. For best results give the lime a chance to work for about a month before applying the manure, compost or other organic matter.

Where clay soils are naturally rich a simple soil amendment is steam cinders from electric generating plants. They are usually given away free or sold at a low cost. Because they contain harmful but soluble residues, they should be piled outside over winter to leach out. Before using, screen them through a ½-inch mesh (four holes to the square inch) to get rid of the large clinkers.

For small areas the use of vermiculite and perlite will break up clay. These minerals are so porous that they will hold five to 10 times their weight in water and admit air freely if not drowned out.

Few soils are too high in silt but when this is a problem the addition of sand and organic matter, plus clay can be used to bring the three materials close to the desired balance of three parts of each.

Finally, in thinking about garden soils it is important to forget the idea that growth in the garden is identical with that in the wild. Our purpose in cultivating plants is not natural growth. We want accelerated, superior growth by which we discipline the plants and make them produce at their maximum capacity. This calls for growing them under highly artificial conditions which make heavy demands upon the elements which only a gardener's loam can supply. So, make it.

For more than three decades, Boston's Fenway Gardens have yielded a bumper crop of food, flowers, and friendship

AN AGELESS TRADITION AHEAD OF ITS TIME

John McGannon

IF it hadn't been for a landfill scheme in the mid-1920s, a world war in the 1940s, and the devoted efforts of a handful of gardeners since then, the Fenway Gardens in Boston's Back Bay would probably not exist today. Even now, it's easy for a casual passerby to miss the gardens. Hemmed in by congested traffic on two sides, and overshadowed by the Prudential Building, the John Hancock skyscraper, and the rest of the towering Boston skyline, the Fenway Gardens are an unsuspected oasis in the midst of a dense metropolitan area. Yet each year the gardens provide nearly 500 Boston residents with a chance to get back to country soil without having to leave the city.

For more than three decades, the Fenway Gardens (and the Fenway Garden Society which voluntarily manages them) have yielded a bumper crop of food, recreation, and new friendships for would-be farmhands from a dozen different Boston neighborhoods. Anyone from metropolitan Boston can apply for a private 15′ x 30′ portion of the garden, and can grow whatever crops he chooses as long as he uses the space allotted to him and keeps his area in good shape. And since the gardens are self-managed, they operate at very little cost to either city or state.

The Fenway Gardens are certainly the first and longest continuing community-run gardens in the country. Their ideas and methods have been adopted by more than seven other neighborhoods in Boston, by at least six nearby suburban communities, and by cities as far-flung as San Francisco and Santa Barbara, California.

The gardens consist of 500 individually cultivated plots, each assigned by the Garden Society according to the time of application, the need of the applicant, and his apparent gardening enthusiasm. At present there is a long waiting list, and it grows each year. The Garden Society also operates an Appearance and Allotment Committee which inspects the gardens from time to time and suggests needed improvements in individual plots.

Virtually every flower and vegetable crop imaginable springs out of the Fenway soil. A few gardens consist entirely of flowers; many raise a mixture of flowers and vegetables.

Several areas have been purposely maintained as uncultivated open spaces, giving to the gardens the atmosphere of a park. Two large groves (complete with benches, picnic tables, and storage boxes for the gardeners' tools), a number of smaller groves, and a series of wide paths divide the private gardens from one another.

The area now known as the Fenway Gardens was not always so well attended. Originally it had been useless swamp land, several feet below its present level, and subject to constant flooding by the Charles River Basin. But in the 1920's the land was filled with thousands of cubic yards of material, most of which came from Boston subway excavations. Some of this was good soil, but a substantial part was debris: bricks by the carload, parts of boilers, pavement, and remnants of buildings. In fact, a little bit of all that had once been Boston was dumped on the Fenway area to raise the ground level and stem the flooding. The site of the future Fenway Gardens had been "created."

With the advent of World War II, the country needed to develop additional food sources for both the armed forces overseas and the general public at home. In 1942 the Boston Victory Garden Committee chose 49 sites (including a large portion of the Boston Common) for cultivation of crops, and one of the areas selected was the unused fill-in along the Fenway. Employees of the Parks and Recreation Department, State and Federal agricultural officials, and teachers from the Boston School Department joined forces to develop the Fens area. They surveyed the land, staked out individual lots, tested the soil, and with the help of residents cleared the land of buried rubbish; then they assigned gardening plots to members of the community.

As the war drew to a close, so did the need for "Victory Gardens," and one by one the sites were returned to former uses. But in the Fenway area a group of interested residents met late in 1944 in an effort to find some way to preserve their local gardens. Richard Parker, an active gardener until his recent death at 84, described their reasons: "We had discovered the joy involved in creating something and watching it grow. The gardens had provided all of us with tremendous relaxation and a chance to work outdoors. We wanted to preserve those feelings, and to continue to have a place where people could work with their hands, and with nature, and grow their own food if they wanted to."

With this general set of principles, some experience in supervising crops during the war years, and a contagious enthusiasm and devotion, the group established the Fenway Garden Society as a volunteer organization.

The city's functions are to dispose of rubbish, insure adequate water supplies and approve the supervisor of the gardens. The Garden Society (from the voluntary dues of \$3 per year which it charges each member) pays for the cost and installation of new water pipes and fixtures, replaces equipment such as lawnmowers and wheelbarrows, oversees the assignment of individual lots and insures their upkeep and arbitrates disputes that may arise between individual gardeners.

Individual gardeners, for their part are asked to work at least six to eight hours a week on their lots (most work more) and to keep them neat. Each must also provide his own tools, fertilizer, lime, and, of course, seeds. The average cost of these to a gardener is about \$10 per season; yet it is possible to grow enough food on a lot to supply the vegetable needs of a family of four for a year, and to save more than \$280 on grocery bills.

Recipe For A Tomato Ring

From The Avant Gardener, May 1, 1975

NEXT year, try the Japanese tomato ring, using this method. Gardeners report harvesting 200 to 250 pounds of tomatoes from a 5-foot circle.

A 13-foot length of 5-foot wide chicken wire or small-mesh welded wire fencing is made into a circle of 5-feet diameter. Stand this upright with the bottom edge set 2 inches deep in the soil in full sun (if chicken wire is used, support it with four evenly spaced strong stakes). Fill the inside of the ring 1 foot to 2 feet deep with a mix of well-rotted or pulverized cow manure, compost and soil. When the weather is warm enough, plant 4 to 6 tomato plants equidistant around the outside of the wire circle. As the plants grow, tie them to the wire with soft twine or strips of nylon stocking.

A depression should be left in the material inside the ring. Water regularly through this depression to supply a constant flow of nutrients to the plants' roots, which will spread out under this core of fertility.

One gardener has developed an interesting variation: she makes compost in the ring, mixing in grass clippings and other garden and kitchen wastes with an occasional sprinkling of soil and fertilizer all through the season.

Carl Ferris Miller's shrub seed offers

BOUNTY FROM KOREA

Carl Ferris Miller, a BBG member living in Seoul, Korea, visited the Botanic Garden in Brooklyn last autumn and related his experience in starting a private arboretum in Chollipo. Mr. Miller, who has spent more than a quarter-century observing Korean native plants, remarked that there are a few choice garden candidates there that have not been introduced to the United States or, if so, only sparingly (and perhaps no longer in cultivation here). Among them are two shrubs belonging to the Bean Family (Leguminosae), *Indigofera pseudotinctoria* and *Camplyotropis macrocarpa,* neither of which have English common names.

Mr. Miller has very kindly sent us a small consignment of seeds of each to share with interested members of the Brooklyn Botanic Garden. If you would like to try them in your garden, send a stamped, self-addressed, business-size envelope to the Editor, BBG, 1000 Washington Avenue, Brooklyn, New York 11225. Orders not filled this spring will be held until autumn depending on the supply. Here are Mr. Miller's notes:

Indigofera pseudotinctoria is a deciduous subshrub growing (in Korea) about 2-3 feet high. Reports from China mention heights of 8 feet but this must be a variety not grown here. It seems to do equally well in sun or shade (although probably best performance can be expected in sun) and is especially attractive in a bank where it can drape down. It is hardy to American Zone 5 (eastern Massachusetts) and probably Zone 4. It may be cut back in the winter but the roots survive and, since it blooms on current year's growth, it could prove an effective ornamental in most of the United States. It can, and perhaps, should be pruned hard each spring to induce new growth.

Flowers are typically pea-shaped but small. They are densely packed in axillary racemes 2-4 inches long and colored pale red to white. The peduncle of the raceme is very short. The shrub blooms over a long period in July and August at Chollipo (Zone 8). This species grows satisfactorily in poor, dry soil but also does well in ordinary garden soil. Pods are dehiscent with thin partitions between the seeds. Leaves are downy on both sides and, as with most indigofera, have stellate hairs. Leaves, up to 2¼ inches long, are alternate and odd-pinnate, with 5, 7, 9 or occasionally 11 leaflets. The species is easily propagated by seeds or by half-ripe cuttings. It is a subtlely attractive ornamental plant.

In Korean this indigofera is called Nang-a cho, which means 'dog's tooth' plant. The same description is used in the West in such common names as dogtooth-violet and dogtooth-grass.

Camplyotropis macrocarpa is also a legume closely related to *Lespedeza,* but the flowers are considered more showy, hence the Korean name ggot-sari, which means flowery-lespedeza. Also deciduous, *C. macrocarpa* grows to about 3-4 feet in height and is hardy to at least Zone 5 and probably Zone 4. As with *I. pseudotinctoria* it may be cut back but will grow again from the roots. Even if not cut back by the weather it is a good idea to prune hard each spring.

Leaves are alternate and trifoliate, leaflets 1-2 inches long, oval in shape, either rounded at the apex or slightly retuse. The upper side of the leaf is glabrous while the underside is heavily covered with sericaceous hairs.

The flowers, in racemes, are rosy purple. The shrub blooms later than *I. pseudotinctoria*—from late August on through October for us. It is easily propagated from seeds.

Both shrubs are worthwhile ornamentals not only for their intrinsic beauty but also, as Donald Wyman would put it concerning their genera, because "they bloom at a time when very few other woody plants are in flower."

RECENT BOOKS WORTH NOTING

In the Library of the Brooklyn Botanic Garden

(Please order directly from your bookstore, not from the Botanic Garden.)

Fruits and Vegetables

The Complete Book of Fruits and Vegetables by Francesco Bianchini and Francesco Corbetta, paintings by Marilena Pistolia. Crown Publishers, New York. $25.00.

The true Italians are given more to fruits and vegetables than Italian-American restaurant menus would suggest. Sources for some of these intriguing vegetables may be hard to find here but worth a search by the gourmand. Beautifully illustrated in color, in fact the year's most attractive volume.

N.Y. Times Book of Vegetable Gardening by Joan Faust. Illustrated by Allianora Rosse. Quadrangle/N.Y. Times Book Co., New York. $9.95

Produce prices go higher and higher and so do book prices it seems, but here's one that may recoup the investment for the new gardener.

Advances in Fruit Breeding edited by Jules Janick and James N. Moore. Purdue University Press, W. Lafayette, Indiana. $20.00

This is basically for the geneticist but has much information for the serious grower interested in the best current varieties. Nuts are included, too.

The Joy of a Home Fruit Garden by Margaret Tipton Wheatley. Doubleday and Co., New York. $6.95

Mainly for mild-climate gardeners, this brief guide is strong on pruning and other cultural techniques but skimpy on varietal recommendations and pest control.

Greenhouse

Organic Gardening Under Glass by George and Katy Abraham. Rodale Press, Emmaus, Pa. $8.95

The bulk of the text is neither "organic" or "inorganic"—just good sound growing information. A chapter on the control of pests is of special interest.

Your Homemade Greenhouse: And How to Build It by Jack Kramer. Walker and Co., New York. $7.95

The Complete Book of Greenhouse Gardening by Ian G. Walls. Quadrangle/New York Times Book Co., New York. $14.95

Did you know that even the Romans had greenhouses of sorts? This comprehensive text from England, with key terms translated into American by Jerome Eaton, provides a mine of useful information for owners, or potential ones, of home greenhouses.

Growing Techniques

Kamuti: A New Way in Bonsai by Willi E. Bollman. Hippocrene Books, New York. $12.50

Different ways to speed up the bonsai process and bring about smaller leaf growth. The author a Rhodesian grower, stresses the immediate training of young seedlings, initial use of larger-than-usual pots, and more frequent root pruning. Excellent diagrams.

N.Y. Times Book of Indoor and Outdoor Gardening Questions edited by Joan Lee Faust and Lisa Oldenburg. Quadrangle/New York Times Book Co., New York. $7.95

Based on queries to the gardening editor of *The Times*.

Diseases of Ornamental Plants revised edition, by Junius L. Forsberg, University of Illinois Press, Urbana. Hardcover $9.95, paperbound $4.00

How to spot and control them, indoors and out.

The Complete Handbook of Pruning edited by Roger Grounds. Macmillian Publishing Co., New York. $12.95

Well-rounded coverage from England.

Hydroponics by Dudley Harris, David & Charles, N. Pomfret, Vermont. $14.95

It's not easy if one wants to go about it scientifically or commercially, but here's a detailed account.

Plant Propagation: Principles and Practices, third edition, by Hudson T. Hartmann and Dale E. Kester, Prentice-Hall, Inc., Englewood Cliffs, N. J. $17.25.

Updating of a standard college text.

Plants in Tubs, Pots, Boxes and Baskets by Leslie Johns. Van Nostrand Reinhold Co., New York. $8.95

Ways to put odd corners to work in the garden, outdoor walls and porches to good use. Prices of containers have soared in recent years, and one of the bits of practical advice in this book from England has to do with making your own boxes and tubs.

Bonsai with American Trees by Masakuni Kawasumi. Kodanska International Ltd., New York. $10.00

A Japanese grower who spent three years in the United States dwells more on the principles and practice of bonsai than on appropriate American trees for this traditional art.

Your Garden Soil by Harry Maddox. David & Charles, N. Pomfret, Vermont. $12.00

An overseas account, rather dry but providing a better understanding of the nitty gritty beneath us.

The Complete Handbook of Plant Propagation by R.C.M. Wright. Macmillan Publishing Co., New York. $12.95

House plants as well as outdoor ones.

History

A Quest of Flowers by Harold R. Fletcher. Edinburgh University Press, Edinburgh. $20.00

The Himalayan travels of English plant hunter Frank Ludlow and George Sherriff. Of special interest to rock gardeners. The author is a former director of the Royal Botanical Garden, Edinburgh.

The Herbal or General History of Plants by John Gerard, 1633 edition revised and enlarged by Thomas Johnson. Dover Publications, New York. Hardcover, $50,00

One of the great classics of gardening, containing over 1,600 pages of lore and fact. Praise be to Dover for taking the plunge.

The Plant Hunters by B. J. Healey. Charles Scribner's Sons, New York. $8.95

Lively acount of the travels of Tradescant, Douglas, Fortune, Farrer and others who introduced many of the plants we grow in our gardens today.

Plant and Planet by Anthony Huxley. Viking Press. New York. $14.95

More on the origin and evolution of the species and the dangers posed them by man today, from the great-grandson of a noted 19th-century scientist. A weighty, provocative book by one who sees the forest as well as the trees. Highly recommended.

House Plants

Fun with Growing Odd and Curious Houseplants by Virginie F. and George A. Elbert. Crown Publishers, New York. Hardcover $8.95, paperbound $5.95

For the restless.

The Complete Book of Houseplants Under Lights by Charles Marden Fitch. Hawthorn Books, New York. $10.95

A worthy addition to the growing number of indoor-light gardening books.

Successful Terrariums by Ken Kayatta and Steven Schmidt. Houghton Mifflin Co., Boston. $14.95

A few novel ideas, including a way to darken perlite if it offends the eye, may be gleaned from this heftily priced but basically sound account.

How to Indentify and Care for Houseplants by Jack Kramer. Doubleday and Co., New York. $8.95

Although hardly a substitute for *Exotica* or its kin, this should be of modest help for beginners who must contend with plant-ignorant clerks in the burgeoning retail outlets for house plants.

Plants That Grow on Air by Jack Kramer. Simon and Schuster, New York. $6.95

Epiphytic bromeliads, cacti, philodendrons and others for walls and hanging baskets.

Seeds and Cuttings by H. Peter Loewer. Walker and Co., New York. Hardcover $6.95, paperbound $3.95

Primarily for the new grower, and even then rather slim.

The World Book of House Plants, revised edition, by Elvin McDonald. Funk E. Wagnalls, New York. $8.95

Updating of a fine earlier book. An illustrated "encyclopedia" gives notes on more than 120 kinds.

The Total Book of House Plants by Russell C. Mott. Delacorte Press, New York. $16.95

An experienced grower formerly with Cornell gives advice on several hundred kinds. Topnotch color illustrations by Alan Singer.

The Plant Doctor by Richard Nicholls. Running Press, Philadelphia. Soft cover $3.95

Intended for the new grower.

The Complete Indoor Gardener, edited by Michael Wright. Random House, New York. Paperbound $7.95

From England, with outdoor notes, too. Well illustrated in color.

Kinds of Gardens

Bible Plants for American Gardens by Eleanor Anthony King. Dover Publications, New York. Paperbound reprint $3.00

Gardening with Wildlife, published by National Wildlife Federation, 1412 Sixteenth St., N.W., Washington, D.C. 20036. $12.95 plus 60¢ postage.

Birdscaping and other tips for the backyard sanctuary. Well illustrated, and a joy to read.

The Scented Garden by Eleanour Sinclair Rhode. Singing Tree Press (Gale Research Co.,), Detroit. $15.00

Republication of a 1931 English classic.

The Shakespeare Garden by Esther Singleton. Republished by Gale Research Co., Detroit. $15.00

A Guide to Water Gardening by Philip Swindells. Charles Scribner's Sons, New York. $7.95

Ideas for garden pools, ponds, bogs and indoor plantings by an English nurseryman. Aquarium plants and fish.

Landscape Ideas

100 Great Garden Plants by William H. Frederick, Jr. Alfred A. Knopf, New York. $15.00

Such lists tend to be subjective and the experienced grower may wonder about criteria, but what distinguishes this book from the average is the author's carefully considered suggestions about artistically companionate plants for each subject.

Color Guide to American Gardening by Arthur Hellyer. Bounty Books (Crown Publishers), New York. $10.95

Although this work doesn't measure up in photographs to others from Crown, there is a lucid text by a well-known English writer. George Kalmbacher of the Brooklyn Botanic Garden served as American consultant.

Fences, Walls and Hedges by Jack Kramer. Charles Scribner's Sons, New York. $8.95 Hardcover; $4.95 Soft cover

For privacy and security, but for beauty, too.

Landscaping Your Vacation Place by Jack Kramer. Charles Scribner's Sons, New York. Hardcover $8.95; Paperbound $4.95

The Avant Gardener by Thomas and Betty Powell. Houghton Mifflin Co., Boston. $12.95 clothbound; $6.95 soft cover

Like any other field, horticulture has its "little" magazines, which often have more substance than the bigger ones, and "The Avant Gardener" is one of the most informative. This book is a selection of the authors' best. Fine source lists in particular.

Make Your Garden New Again by Stanley Schuler. Simon and Schuster, New York. $9.95

Gardens, even the best of them, are not forever and, with the slump in development of new homelots, an ever-larger number of property owners are turning to renovation. Practical advice on how to go about it.

Miscellaneous

Gardening in the Carolinas by Arnold and Connie Krochmal. Doubleday and Co., New York. $7.95

Wild Plants in the City by Nancy M. Page and Richard E. Weaver, Jr. Demeter Press (Quadrangle/New York Times Book Co.), New York. Paperbound $3.95

More than ninety urban weeds of the Northeast are described with clear line drawings and photographs. Reprint of a publication from the Arnold Arboretum (Boston).

Ancient Dyes for Modern Weavers by Palmy Weigle. Watson-Guptill Publications, New York. $8.95

Henna, weld and alkanet? Witches' names, no, but they cause a certain alchemy in the dye pot. Many other recipes are included in this contribution by the guest editor of Brooklyn Botanic Garden's most recent Handbook on dyeing ("Natural Plant Dyeing").

Plant Groups

Gentians by Mary Bartlett. Hippocrene Books, New York. $12.50

Conifers for Your Garden by Adrian Bloom,

Perennials for Your Garden by Alan Bloom,

Shrubs for Your Garden by Peter Seabrook. Charles Scribner's Sons, New York. $8.95 each

Excellent color photographs characterize these volumes by leading English growers, but the search for many of the plants described will frustrate American gardeners.

Wild and Old Garden Roses by Gordon Edwards. Hafner Press (Macmillan), New York. $9.95

Gladioli for Everyone by John B. Garrity. David & Charles, N. Pomfret, Vermont. $9.95

Cacti and Other Succulents by R. Ginns. David & Charles, N. Pomfret, Vermont. $9.95

Ornamental Conifers by Charles R. Harrison. Hafner Press (Macmillan), New York. $17.95

They aren't all somber green pyramids by any means, and this New Zealand nurseryman presents an array of color photographs to show their considerable variety.

Low Maintenance Perennials by Robert S. Hebb. Quadrangle/New York Times Book Co., New York. Soft cover $4.95

Particularly valuable for keyed nursery sources. The original material appeared in "Arnoldia."

The Laurel Book by Richard A. Jaynes. Hafner Press (Macmillan), New York. $10.95

A leading chestnut breeder takes time off to discuss one of America's loveliest shrubs, mountain-laurel, as well as other kalmias, their variability, and the breeding possibilities.

Cacti and Their Cultivation by Margaret J. Martin, P. R. Chapman, and H. A. Auger. Charles Scribner's Sons, New York. Paperbound $4.95

Ornamental Grasses by Mary Hockenberry Meyer. Charles Scribner's Sons, New York. $9.95

Most viewers of B.B.G.'s border of ornamental grasses in autumn consider it one of the Garden's top seasonal attractions, but very little has appeared in print about the variety and care of these distinctive plants. The author has provided a most worthwhile introduction.

Fuchsias in Color by Brian & Valerie Proudley. Hippocrene Books, New York. $7.95

The Vanishing Lichens by David Richardson. Macmillan Publishing Co., New York. $12.00

They've been trod upon too long. Did you know the Japanese grow one kind for food? That lichens have been used in embalming, not to mention dyeing? Professor Richardson tells the story well and at times poignantly.

The Orchids: Scientific Studies edited by Carl L. Withner. John Wiley & Sons, New York. $22.50

Companion volume to an earlier work compiled by B.B.G.'s former orchid curator.

Trees

Diseases of Midwest Trees by J. Cedric Carter. University of Illinois Press, Urbana, Illinois. $8.95

Helpful for backyard diagnosis and treatment. Not overly technical. Of wider geographical application than the title suggests.

Caring for Trees on City Streets by Joan Edwards, for the Environmental Action Coalition, Charles Scribner's Sons, New York. $6.95

General but practical tips are included in this short book intended mainly for younger readers. The author is in charge of the Magnolia Tree Earth Center, a group that has involved children in the care of street trees in the Bedford-Stuyvesant section of Brooklyn.

The Blossom on the Bough by Anne Ophelia Dowden. Thomas Y. Crowell Co., New York. $7.50

Yes, trees have flowers too, and one of America's leading floral artists writes about them simply, clearly and gracefully. A first-rate introduction.

Hillier's Manual of Trees and Shrubs, Fourth Edition, Hillier & Sons, Winchester, England. $6.00 soft cover; $14.00 hard cover

In the five years since its appearance, the "catalogue" from the world's largest nursery has become a standard reference work. This is a minor updating, with a more important one several years off.

Woodland Ecology by Leon Minckler. Syracuse University Press, Syracuse. University Press, Syracuse. $9.95

What to do with the back 40 when the garden gets beyond the gardener. A tree-top guide to forestry practice on the country property.

Plant a Tree by Michael Weiner. Macmillan Co., New York. $15.95

The author has relied extensively on pamphlets from various tree-planting and forestry groups in this somewhat rambling, well intended compilation. Also descriptions of more than 170 species.

Nylon For Drainage

From American Horticultural Society NEWS & VIEWS, Jan. 1975

FROM the *California Garden* comes a novel idea for a simple, handy and effective technique for bottom-of-the-pot drainage. Instead of using shards or pebbles in the bottom of the flower pots, Mrs. Anuta Lynch uses balls of nylon stocking to provide perfect drainage while keeping soil from sifting through the hole. She reports it never shifts or plugs up the drainage hole and lasts for years. In one instance a repotting after ten years found the nylon still intact.

Here are her instructions: Roll a wad of nylon stocking into a ball slightly larger than the diameter of the hole, then stuff it firmly into the hole. A large pin through the knot across the bottom will hold it in place after the pot is filled.

The nylon ball is equally effective in clay, plastic or ceramic pots. In pots where bottom drainage holes are located at the sides, cover the entire bottom of the pot with nylon, extending it up the sides sufficiently to cover all holes. Sift the soil into center of the pot first, then out to the edges, to hold the nylon in place. For larger pots, sphagnum moss wrapped in the nylon balls will create volume without an excess of nylon.

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